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Electricity on Farms in the Eastern Livestock Area of Iowa¹

A Progress Report

By

JOE F. DAVIS and PAUL E. STRICKLER,² *Agricultural Economists,*
Bureau of Agricultural Economics

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¹ Project No. 1135 of the Iowa Agricultural Experiment Station and Project No. 138, RMA 10 (b) of the Bureau of Agricultural Economics. Project 138 was financed in part by funds appropriated under authorization of the Research and Marketing Act.

² Many persons gave valuable suggestions for improving this study, especially M. R. Cooper and Ross V. Baumann of the Bureau of Agricultural Economics; Earl O. Heady, Hobart Beresford, and H. H. Beaty of the Iowa Agricultural Experiment Station; and J. P. Schaezner of the Rural Electrification Administration. The sample for study was selected by the Iowa Statistical Laboratory. Ruby G. McWhirt was responsible for most of the computations. Credit is also due the 10 enumerators who took the records, the farmers who gave the information, and the suppliers of electricity who provided the data on consumption.

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SUMMARY AND CONCLUSIONS

Farm electrification has made rapid progress in the part of Iowa that comprises the eastern livestock-producing type-of-farming area. Farm after farm has been quickly added to the number that have electric service and the actual use of electricity in farm homes and service buildings has steadily expanded. Supplying farmers with electricity and electrical equipment has become a big business in eastern Iowa.

At the beginning of 1947, approximately 87 percent of the 44,000 farms in the 19 counties that make up this type-of-farming area were receiving service from a power line. Occupants of these farms spent about \$3,000,000 for the electricity they used that year. In addition, they spent in the neighborhood of \$10,270,000 that year for electrical equipment and for wiring farmsteads. Thus, in 1947, their total expenditure for electricity and electrical equipment was approximately \$13,270,000—an average of \$350 for each electrified farm.

In addition, power lines were extended to several hundred more farms in the area in 1947 and they are still expanding. With construction proceeding so rapidly electrical service will be available to virtually all farms in the area within a few years.

That these Iowa farmers would have bought more electrical equipment and appliances and therefore would have used more electricity, if these items had been available in larger quantities during the war years, goes without question. That they will continue to expand their consumption of electricity, mainly through the use of more electric equipment, is just as certain. It seems reasonable to expect that within a few years, say by 1960, the average annual consumption of electricity per farm in this area will be at least double what it was in 1947, and that total consumption by all farms in the area (because more farms will be electrified) will be $2\frac{1}{2}$ times as great. These estimates assume a continued high level of farm prosperity in the area and power line service that is adequate to the demands of the farms.

The survey upon which this report is based was made in the eastern livestock-producing type-of-farming area of Iowa in April 1948. Records were obtained from 461 farms selected at random and intended to be representative of all electrified farms (approximately 37,850 of

them) in the area. The Iowa Agricultural Experiment Station and the Bureau of Agricultural Economics cooperated in carrying out the study.

This is one of several studies made or in the planning stage for each of the major type-of-farming areas of the country. These studies are intended to develop information that will help those concerned with the generation and distribution of electric power in rural areas and to help farmers make the organization adjustments in their homes and farms that are necessary to utilize fully this source of energy.

The amount of electricity used per farm in 1947 in the sample studied in Iowa in this survey was 2,174 kilowatt-hours (excluding farms electrified during that year) or $2\frac{1}{2}$ times the average of 812 kilowatt-hours that was used 10 years earlier. This increase came about mainly through the installation and use of electrical equipment rather than through an increase in the use of electricity for lighting. In 1938, about half of the electricity used on these farms was used for lighting purposes; by 1947 lighting accounted for only about one-fifth of the total.

Practically every kind of equipment that had been employed on the farms in 1938 was used by a larger proportion of the farmers in 1947. For example, the use of electric refrigeration had spread from about 30 percent of the electrified farms in 1938 to 80 percent in April 1948. Several new uses for electricity were introduced during the decade. The freezer cabinet was not used in 1938 but of the 461 farms in the sample 47 had one in 1948. Electric welders for farm shops were used on 40 of the farms in 1948 but none of them had one in 1938. It should be recognized however that farm incomes were generally rising during the decade, 1938-48.

Four-fifths of the electricity used on the sample farms in 1947 was used in the households. Small farms and residential places had little need for electricity outside the home. About 88 percent of all electricity used by the low-income farms in 1947 was used in the home. The larger farms, with their livestock enterprises and their considerable electrical equipment, used more electric energy in farm production. Electric power is flexible and well suited to automatic and semi-automatic operations so that it was commonly used for operating milking machines, water pumps, brooders for both pigs and chicks, and certain shop tools. Tractors were still the usual source of power on these farms for belt work, such as grinding feed and elevating grain.

As a general rule, a farmer wires the farm dwelling, or dwellings, and most of his substantial service buildings, and installs a few pieces of electrical equipment as soon as the farm is connected with a power line. As time goes on, the farmer buys more and more electrical equipment so that the average consumption of electricity among farms increases each year. There is no indication that farms in this area ceased to increase their use of electricity even after 30 or more years of service. The increase in per farm consumption during the decade 1938-47 averaged 10.5 percent per year on the farms studied.

By the beginning of 1947, newly electrified farms in eastern Iowa were starting out at a much higher level of electrification than was true of the newly electrified farms of a decade earlier. On an average, farms in their first year of electrification, that is, those electrified in 1946, used more electricity in 1947 than the farms that were electrified before 1930 used in either 1938, 1939, or 1940. In general, during the first

5 years after the farms were electrified farmers installed a wide variety of household equipment—radios, irons, clocks, toasters, washing machines, and refrigerators—but it usually took some time for large numbers of them to convert to the more expensive devices that use electric energy, such as water systems, ranges, and water heaters.

The greatest increases in the consumption of electricity in this decade took place on the farms that have high incomes. These farms generally were larger in both acreages and animal units, and they conducted larger farm businesses, than farms of lower income. They had greater need for electricity and they had the money to buy the equipment, whether for use in the household or on the farm, and to pay for the electricity used.

High-income farms that had been electrified for 5 or more years, spent less than half of one percent of their 1947 total incomes for electricity while the low-income farms electrified for 5 or more years spent 1.8 percent. This meant an average electric bill of \$106 per year, or \$8.83 per month for the high-income farms, and about \$61 per year, or \$5.08 per month for the farms with low incomes.

Of the sample studied, approximately one-fourth of these older electrified farms were classified as high-income farms and one-fourth as low-income farms in 1947. Apparently the cost of the electricity did not limit the use of this source of energy on the larger farms, but it may have done so on the small ones.

A more important economic consideration affecting the amount of electric energy used is the cost of the electrical equipment and appliances. As the installation of water systems with electric water heaters, electric ranges, and most other items that require a great deal of electricity is relatively expensive, these things are introduced gradually on most farms. Farmers with low incomes were especially slow to install them.

The average amounts of electricity used in 1947 by the various types of commercial farms in the sample—hog, beef-hog, cash-crop, and general—were within 126 kilowatt-hours of the average for all commercial farms. The average for the commercial farms was 2,277 kilowatt-hours but this was 84 percent greater than the average amount used by the noncommercial farms.

Prospects for increasing the use of electricity on farms in this area appear to be bright. Specifically, and based on the data collected in the survey, it is expected that by about 1960 the average amount of electricity used per farm will be 4,500 kilowatt-hours or more compared with 2,174 kilowatt-hours in 1947. At this level of consumption, the total amount used by all farms in the 19 counties will be in the neighborhood of 200,000,000 kilowatt-hours, compared with 82,300,000 kilowatt-hours used in 1947.

The year 1960 is used merely for convenience in looking ahead. Actual consumption of electric energy at that time must necessarily depend upon economic conditions, engineering developments, and other factors, but the estimates given here appear at this time to be reasonable.

PURPOSES OF STUDY

Extension of electric power lines to rural areas has brought to millions of farm people the possibility of having labor-saving facilities that

had been available only to urban people. The general farm electrification movement is so new that the full use of electricity in farm homes and service buildings, and in the service areas is yet to be realized.

The study here reported is one of a series of related studies that deal with certain economic aspects of farm electrification. Studies have now (March 1950) been started in the States of Georgia, Kansas, Tennessee, and Washington.

In their broad aspects, these studies are being made to develop information leading to more economical distribution systems in rural areas and to assist farmers in effecting labor savings in the production of crops and livestock in various farming areas.

This study in Iowa was undertaken to make available to farmers and to suppliers of electricity the experiences of farmers who have used electricity for some time, as a basis for evaluating farm-use potentialities in the field. Another purpose was to examine the relationships between certain economic and physical farm conditions as they relate to the use of electricity; the principal conditions considered were type of farm, size of farm, size of specific enterprises, farmer's income, and tenure of operator. A third purpose was to analyze the costs of using electricity, including the costs of the energy used, of farmstead wiring, and of electrical equipment and appliances. A fourth purpose was to discover some of the principal effects of electrification on the organization and operation of the farms, with special reference to changes in productive enterprises and uses of power resulting from electrification.

Agencies, public and private alike, in facilitating the electrification of rural America have encountered difficult administrative problems as the power lines have been extended into rural areas. Many of these problems hinge on the question of how much electricity the farms in a specific area may be expected to use, and the peak demands that may be expected during the year. Consumption of electricity depends on the size and character of the farm business, and on other factors, as well as on the question of income which influences sharply the purchase of electrical equipment and appliances.

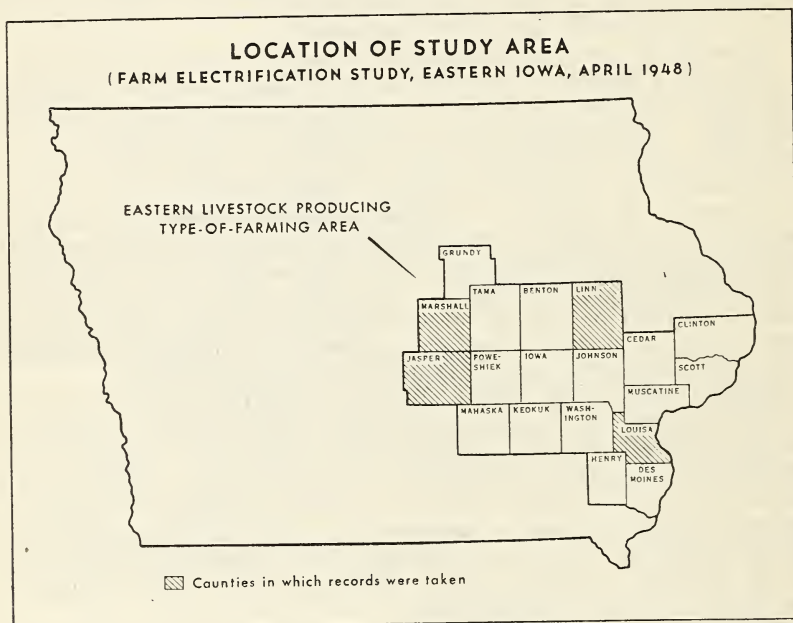
Answers to these questions cannot be foretold exactly, but estimates of the answers lie back of every administrative decision, from those concerned with providing the power supply to those that determine the design of the wiring system on a farm and the establishment of the schedules of rates for the area. Some estimates lie back of any farmer's decision as to how much electric energy he will probably use—and for what purposes.

It is believed that the criteria established in this and in similar studies, will help to provide a basis for administrative decisions concerning financing, engineering, and rate making, as distribution systems are extended into new areas and as old systems are rebuilt and maintained. The experience of farmers in the area studied should aid other farmers when they are planning features of farm organization and operation that involve the use of electric energy in replacing labor and for other forms of farm power.

STUDY AREA AND PROCEDURES

The eastern livestock area was selected as the location for that part of the over-all study that was to be made in Iowa. This area includes 19

counties indicated in figure 1. It covers 10,898 square miles, 96 percent of which is in farms. The average size of farm, as shown by the census of agriculture, was 153 acres in 1944. Approximately 60 percent of all land in farms was classified as cropland harvested. Almost two-thirds of the 1944 gross farm income was derived from the sale of livestock and livestock products other than dairy products, poultry and poultry products.³ Of the 43,628 farms in the area in 1945, 31,205 had electricity in the farm home.



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FIGURE 1.—The 19 counties here mapped comprise the area in which the farm-electrification study was made. The sample of farms was drawn from the 4 counties indicated by the shading.

This area was chosen for study for four principal reasons. First, grain and livestock production are the main farming enterprises and farming practices are similar to those followed in much of the Corn Belt. Acreages of the various crops and numbers of livestock on the farms studied are shown in Appendix tables 47, 48, 49, and 50. Second, electrification of farms in this area was begun a good many years ago, so that a random sample of farms included many that had had 10 or more years of experience with electricity. Third, the area is one of relatively high farm incomes so that, for many farms, the limitations of income might not be the principal limitation in the use of electricity. Fourth, this is basically an agricultural area—most of the farmers are

³ For a more complete description of the area see HOLMES, C. L., and CRICKMAN, C. W. TYPES OF FARMING IN IOWA II. Iowa Agr. Expt. Sta. Bul. 374, pp. 163-248, illus. 1938.

fully employed on their farms. Only two cities in the area have a population of more than 50,000.

The farms included in the study were selected at random by the area method in 4 of the 19 counties. These 4 counties—Jasper, Linn, Louisa, and Marshall (fig. 1)—were also drawn at random from strata based upon the percentage of farms electrified. Maps of the counties were divided cartographically into sampling units or segments of such sizes that they would average about four farm headquarters per segment. Enough of these sampling units were drawn at random to include approximately 100 electrified farms per county.

A record was taken for each farm within the sampling segments drawn, provided the farm had received electricity on or before January 1, 1947. Residences used in connection with stores, filling stations, or other commercial enterprises were excluded from the sample, as were all farms that were not in the open country.

A total of 461 farms were included in the survey. At the time of the survey, in April 1948, tenants were operating 174 of the farms. Geographically, the sample included 119 farms in Jasper County, 112 in Linn County, 124 in Louisa County, and 106 in Marshall County. Power companies and municipalities provided 215 of the farms with electricity and rural electric cooperatives supplied 246 farms. The sample represented approximately 1.2 percent of all the electrified farms in the 19 counties.

The farm records were obtained through personal interviews with the farmers. Most of the interviewers were students from Iowa State College; all were supervised by technicians either of the Bureau of Agricultural Economics, United States Department of Agriculture, or of the Iowa Agricultural Experiment Station.

After the farm records were taken, the names of the farm operators were given to their respective suppliers of electricity. These suppliers provided the records of kilowatt-hours used and the cost of the electricity used by each farm in the sample. These data were provided without expense to the study. Consumption and cost data were obtained for the 10-year period 1938–47, or for such parts of that period as the farm was electrified and the records were available. Records were obtained for any included farm regardless of changes in occupancy during the period of record. No changes in occupancy occurred on 65 percent of the farms during the period of record but on some the occupancy had changed two or more times.

GROWTH OF FARM ELECTRIFICATION

Extensive use of electricity on farms is a relatively new development in American agriculture. On January 1, 1920, the United States had only about 100,000 electrified farms.⁴ By January 1, 1935, the number had increased to 744,000, which was about 11 percent of all farms. After 1935, the rate at which farms were electrified speeded up considerably, and since the end of war hostilities in 1945 electrification in this country has proceeded at the rate of about 460,000 farms each year.

⁴ The term "electrified farm" as used herein refers to farms receiving electricity from a power line. It does not apply to farms that have home generating plants only. Data as to numbers of electrified farms are from reports of the Rural Electrification Administration and U. S. Census of Agriculture.

More than $4\frac{1}{2}$ million farms in the United States are now receiving central-station electric service. This is almost four-fifths of all the farms. Approximately 60 percent of these electrified farms first had service after 1940. Construction of additional electric power lines in rural areas is proceeding rapidly; by July 1950, close to 5 million farms will have this service. From the figures it seems reasonable to believe that electricity from a power line will be available to 95 percent of all farms in this country within 4 or 5 years.

Iowa has been consistently above the average of the States in the percentage of farms electrified. In 1935, more than 14 percent of its farms were connected to a power line, as compared with the United States average of 11 percent. In 1945, the percentages had increased to 59 and 46 respectively, and by June 30, 1949, to 86 and 78 percent. The number of electrified farms in Iowa increased from 32,000 in 1935, to 73,000 in 1940, and 180,000 in 1949.

Providing electricity and providing electrical equipment for farmers have become important commercial enterprises during the last few years. In 1947, the total farm expenditure for electricity in these 19 counties in the study area was approximately \$3,000,000.⁵ This is about four times as much as was spent for electricity by farmers in the area in 1938, and the money bought almost seven times as much electricity. The increase in total consumption was caused both by the increase in the number of electrified farms and by an increase in the amount of electricity used per farm.

During the decade 1938-47, the average amount of electricity used per farm in the study increased more than 168 percent. However, the average expenditure per farm for electricity used increased from \$56.93 in 1938, to only \$78.81 in 1947, or by less than 40 percent.

A part of the difference between the increases in consumption and the increase in costs per farm can be accounted for by reductions in the rates charged by suppliers. Another part came about because each of the suppliers in the area had a promotional rate (or rates) for farm consumers. The rate structures were similar in one respect—the average charges per kilowatt-hour declined when the use of electricity exceeded an established minimum amount. A more complete discussion of rates is included in the following section of this report.

Expenditures for electricity usually occur at regular intervals—once a month for most farms, quarterly for some, and annually for others. But electricity cannot be used on a farm until investments of a more-or-less permanent nature are made. Included in this category are expenditures for farmstead wiring, for fixtures and lamps, electric appliances, and electric motor-driven equipment. The average of such investments made in 1947 by the 461 farmers in the survey was estimated to be \$271. When the average cost per farm for the energy used is added to this, the average total expenditure in 1947 for electricity, wiring, fixtures and lamps, electric appliances, and electric motor-driven equipment becomes \$350 per farm.

⁵ This estimate includes only those farms that were electrified on or before January 1, 1947, estimated at 37,850. The estimate is based upon the number of farms with electricity (31,205) as reported by the 1945 Census of Agriculture and by the percentage of increase between 1945 and 1947, as indicated by the sample of farms in this survey. No data are available for expenditures by farms electrified during the year 1947.

As most of the farms had been connected to a power line for a number of years, the bulk of the more-or-less permanent investments were made before 1947. An accurate account of all these costs cannot be reconstructed at this time, but estimates were made. They were based on the installation dates of major pieces of equipment, the estimated average costs in those years, and the cost of wiring as reported by the farmers. This estimated total is \$1,340 per farm, or approximately \$51,000,000 for all farms in the area (table 1).

TABLE 1.—*Estimated cost of wiring and electrical equipment and appliances on farms in the project area in 1947, and total cost from time of electrification to April 1948¹*

Item	1947 costs		Costs from time electrified to April 1948	
	Total	Average per farm	Total	Average per farm
	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>	<i>Dollars</i>
Wiring.....	270,000	7.15	9,084,000	240.00
Fixtures and lamps.....			2,650,000	70.00
Household appliances.....	8,079,000	213.44	26,495,000	700.00
Farm equipment.....	1,921,000	50.76	12,490,000	330.00
Grand total.....	10,270,000	271.35	50,719,000	1,340.00

¹ Based on an estimated 37,850 farms, electrified on or before January 1, 1947, in 19 counties in the project area and on average prices, obtained from ELECTRICAL MERCHANDISING, January 1949. Prices of a few small items were from other sources.

USE OF ELECTRICITY ON OLDER AND NEWER ELECTRIFIED FARMS

Average annual consumption of electric energy⁶ on all farms in the sample increased from 812 kilowatt-hours in 1938 to 2,174 in 1947. Each year for the first 9 years of the decade, the increase averaged around 9.6 percent. From 1946 to 1947 the increase was exceptionally large—499 kilowatt-hours per farm, or 30 percent of the amount used the preceding year.

Included in these averages are farms that have been using electric energy from central-station sources for different lengths of time. Some were electrified as early as 1917; others as late as December 1946. Furthermore, the relative importance of the newly electrified farms in the over-all average varied considerably from year to year. For example, almost one-fourth of the 74 farms for which a record of consumption for the year 1938 was available were in their first year of electrification.⁷ Consumption records obtained for 160 farms for 1940 showed that more than a third had been electrified the preceding year. But after 1940, the proportion of first-year farms in the area tended to decline, amounting to only 8 percent of the 461 farms for which records were available in 1947. As electrification approaches a complete coverage

⁶ From central-power sources only. Power generated by home plants is not considered in this report.

⁷ The first year of consumption is considered to be the first full calendar year after the farm is electrified. For example, the first year of consumption of a farm electrified, say, in June 1945, is the calendar year 1946. Records were not tabulated for that part of 1945 during which the farm had service.

of the area, the influence of the first-year farms on the over-all average will continue to decline.

As the newly electrified farms generally have less electrical equipment and use less electric power than the older electrified farms, it becomes desirable for some purposes to classify the farms according to length of electric service. To ascertain the suitable breaking points in making the classification, the consumption records of the farms by dates of electrification were studied.

In the 13 age groups selected for study two outstanding characteristics of the consumption data for the period 1938-47 appear (table 2). First, for each consumption year, farms that were in their first year of consumption usually used less electricity than those in other electrified age groups; and second, all electrified age groups steadily increased their average consumption. The annual increases in consumption of electricity between 1938 and 1945 were fairly constant, but in 1946, the increase was rather pronounced, and in 1947 the increase was sharp. Both of these characteristics are later examined more fully.

Average consumption of all farms in the sample ranged from 5 percent more than the first-year farms in 1938, to 93 percent more than the first-year farms in 1944. In 1938, the first-year farms used 775 kilowatt-hours compared with an average of 812 kilowatt-hours for all farms that year. By 1947, the first-year farms had increased their consumption to 1,286 kilowatt-hours while the average for all farms had increased to 2,174 kilowatt-hours. In each of the other 8 years, the first-year farms used less electricity than did the average of all farms, the difference being one of degree; 886 to 1,675; 775 to 1,107; and so on.

In 1938, in no electrified age group did farms consume as much as 1,000 kilowatt-hours, on the average. But 7 years later (1945) only 1 age group used less than 1,000 kilowatt-hours per farm, and 2 groups were using an average of about 2,000 per farm. By 1947, no age group used less than 1,100 kilowatt-hours per farm and 9 of the 13 groups were using between 2,000 and 3,400 kilowatt-hours per farm.

All of the age groups that averaged less than 2,000 kilowatt-hours in 1947, had been electrified in 1943, and later years. Conversely, all of those that averaged more than 2,000 kilowatt-hours had been electrified before 1943. In those groups that had been electrified before 1943, no significant relationship was found between the amount of energy consumed in 1947 and the length of time the farms had used central-station electric service. These data suggest that a suitable breaking point for use in classifying farms in this area into two groups that represent the older and newer electrified farms is between the fourth and fifth consumption year. In one group are the farms that had been electrified less than 5 years; in the other those that had been electrified for 5 years or longer.

In this report, therefore, the term "newly (or newer) electrified farms" pertains to those which, at any given time, have had the service for less than 5 years; "old (or older) electrified farms" pertains to those which at any given time have had the service for 5 years or longer. The newly electrified farms in 1947, for example, are those that were electrified after January 1, 1943, but the newly electrified farms in 1940 are those that were electrified between January 1, 1936, and December 31, 1939.

Year or period of electrification

Farms represented

[illegible]

This distinction between the newer electrified and the older electrified farms does not imply that farms cease to expand their use of electricity after 5 years of service. Actually, the farms in this area continued to increase the amount of electric energy used, even after a quarter-century of service. The classification is made only because there is such a distinct difference between the consumption habits of these two groups. For the year 1947 the newly electrified farms, as here defined, used an average of 1,367 kilowatt-hours whereas the older electrified farms used 2,551 kilowatt-hours, or almost twice as much. This is a striking difference between the total consumption characteristics of the two groups. Just as striking is the difference in the distributions of farms when classified by the amount of energy used.

Almost half of the newly electrified farms used less than 1,000 kilowatt-hours and approximately 84 percent used less than 2,000 kilowatt-hours in 1947 (table 3). Of the older electrified farms, about a fifth used less than 1,000 kilowatt-hours and a half used less than 2,000. Only 1.4 percent of the newly electrified farms used 5,000 kilowatt-hours or more in the year, but 11.1 percent of the older electrified ones used this much. None of the newly electrified farms used as much as 8,000 kilowatt-hours in 1947, but six of the older electrified farms used this much or more.

The question may be raised as to whether these differences in the 1947 consumption are due to differences in the physical and economic characteristics of the farms, or merely to the length of time that the farms had had the service.

Two major differences are found in the farms of the two principal age groups. (1) The proportion of high-income farms, those grossing \$15,000 and over, was somewhat larger in the older electrified farm group. One-fourth of the farms electrified before January 1, 1943, had incomes of \$15,000 or more but only 11 percent of the newly electrified farms had such incomes. (2) The proportion of noncommercial farms was larger in the older electrified than in the newer electrified group. More than 11 percent of the older electrified farms were classified as noncommercial, as compared with less than 7 percent of the newer electrified farms. Later it is shown that, in general, the high-income farms use more electricity than do those with low incomes, and that the noncommercial farms use less electricity than the commercial farms. These differences between the two age groups tended to offset each other.

The older electrified farms, as a group, were a little larger (169 acres compared with 155), had more livestock (42 animal units compared with 38³), and had higher average incomes in 1947 than did the newly electrified farms (\$11,600 and \$8,700). But farmers in each group had good incomes, all things considered; and the differences are so small that they can perhaps account for only a small part of the difference between the groups in the use of electricity. Most of this difference is apparently due to the fact that operators of the older electrified farms had more time to become acquainted with electrical devices and to buy the ones they wanted.

The average yearly consumption of electric energy by farms that had been electrified for 5 years or more was almost trebled in the decade 1938-47. The average amount used in 1938 was 893 kilowatt-hours;

³ For factors used in calculating animal units, see Appendix table 52 (p. 88).

TABLE 3.—*Variation in the consumption of electric energy in 1947, by period of electrification*¹

Date of electrification	Farms using indicated kilowatt-hours									
	All farms	Under 1,000 Kw.-hrs.	1,000 to 1,999 Kw.-hrs.	2,000 to 2,999 Kw.-hrs.	3,000 to 3,999 Kw.-hrs.	4,000 to 4,999 Kw.-hrs.	5,000 to 5,999 Kw.-hrs.	6,000 to 6,999 Kw.-hrs.	7,000 to 7,999 Kw.-hrs.	8,000 and over Kw.-hrs.
Before Jan. 1, 1943	Number 314	Number 62	Number 98	Number 66	Number 28	Number 25	Number 9	Number 12	Number 8	Number 6
After Jan. 1, 1943	147	71	52	13	4	5	1	1	1	-----
All farms	461	133	150	79	32	30	10	12	9	6
Percentage distribution										
Before Jan. 1, 1943	Pct. 100	Pct. 19.8	Pct. 31.2	Pct. 21.0	Pct. 8.9	Pct. 8.0	Pct. 2.9	Pct. 3.8	Pct. 2.5	Pct. 1.9
After Jan. 1, 1943	100	48.3	35.4	8.8	2.7	3.4	.7	-----	.7	-----
All farms	100	28.9	32.5	17.1	7.0	6.5	2.2	2.6	1.9	1.3

¹ See p. 10 for method of determining periods.

in 1947 it was 2,551 (table 4). The average rate of increase during the decade was 10.7 percent per year.⁹ This rate was fairly constant for 8 of the 10 years, the exceptional years being 1944 and 1947. In 1944, the increase was only 1.8 percent. At that time, electrical appliances for home use were in short supply because of wartime restrictions on production. In 1945 and 1946 these appliances were more readily available but not until 1947 could the pent-up demand of farmers for such equipment be largely satisfied. Consequently, the average amount of energy used by these older electrified farms increased from 1,917 kilowatt-hours in 1946 to 2,551 kilowatt-hours in 1947, an increase of 33 percent in the single year.

TABLE 4.—Average annual consumption of electric energy, by periods of electrification, 1938-1947

Year of consumption	Period of electrification ¹				All farms
	First year	Less than 5 years	5 years and over	10 years and over	
	<i>Kw.-hrs.</i>	<i>Kw.-hrs.</i>	<i>Kw.-hrs.</i>	<i>Kw.-hrs.</i>	<i>Kw.-hrs.</i>
1938.....	775	680	893	930	812
1939.....	743	781	1,024	1,020	900
1940.....	687	797	1,109	1,078	908
1941.....	847	949	1,228	1,393	1,034
1942.....	775	1,001	1,316	1,399	1,107
1943.....	824	1,105	1,519	1,533	1,271
1944.....	702	1,126	1,546	1,678	1,354
1945.....	1,105	1,045	1,691	1,775	1,465
1946.....	886	1,138	1,917	2,073	1,675
1947.....	1,286	1,367	2,551	2,969	2,174

Farms represented					
	Number	Number	Number	Number	Number
1938.....	18	28	46	30	74
1939.....	20	50	48	34	98
1940.....	56	103	57	44	160
1941.....	62	169	74	51	243
1942.....	43	190	97	56	287
1943.....	21	185	124	58	309
1944.....	27	154	183	61	337
1945.....	39	132	245	70	377
1946.....	44	132	292	77	424
1947.....	37	147	314	97	461

¹ Periods represent the length of time the farms had been electrified at the beginning of the year of consumption shown in the first column.

Farms electrified for less than 5 years doubled their average consumption of electric energy during the decade, rising from 680 kilowatt-hours in 1938, to 1,367 in 1947. This was a substantial increase in consumption for the period as a whole, but the year-to-year changes were much less constant than for the older electrified farms (fig. 2). For example, the consumption of electric energy from 1944 to 1945 decreased 7 percent but from 1946 to 1947 it increased 20 percent. For the period as a whole the average rate of change was 6.8 percent per year.¹⁰

⁹ A calculated regression equation, $Y_c = 895 (1.107^x)$; 1938 = 0 where Y_c is the calculated kilowatt-hours and x is the number of years after 1938.

¹⁰ A calculated regression equation $Y_c = 928 (1.068^x)$; 1938 = 0 where Y_c is the calculated kilowatt hours and x is the number of years after 1938.

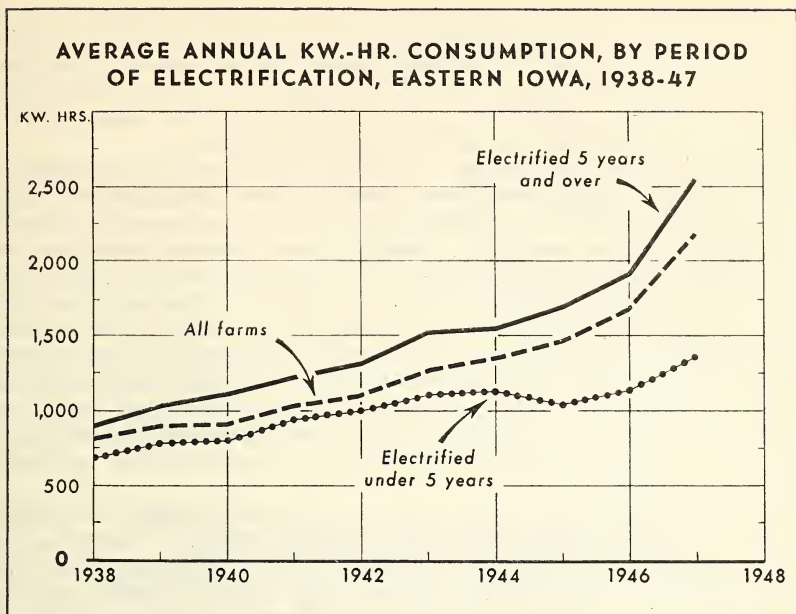


FIGURE 2.—Between 1938 and 1947 the annual consumption of electric energy about trebled on the older electrified farms and about doubled on the newly electrified farms.

CAUSES OF GROWTH IN CONSUMPTION OF ELECTRIC ENERGY

Behind these increases in consumption, a host of forces were at work. A few of the more conspicuous ones were: Improvement in electrical equipment and appliances, increased acquaintance of farmers with possible uses and costs of electricity, increased farm incomes, competition from other power sources, (for example, liquid petroleum gas), improvement in the ability of farmers to handle mechanical devices, and the installation of water systems in farmhouses. It is impossible to isolate and measure accurately the contribution of each of the forces that were active during the decade; all of them operated simultaneously. It appears desirable, however, to consider briefly (1) the general level of farm prosperity and (2) the kinds of electrically powered equipment used on farms.

IMPROVEMENT IN ECONOMIC CONDITIONS

From the standpoint of farm prosperity, the decade 1938-47 may be divided into three parts. (1) During the first 3 years the economy was emerging from the depression of the 1930's; the flood of forced liquidations of farm debts had passed and farmers were viewing the future with more confidence. (2) World War II as far as the United States was concerned, was fought in 1941-45. It brought with it an insatiable demand

for food, fiber, machines, and men. Stocks of food and fiber were depleted and prices soared to the limit set by wartime controls. (3) After 1945 came the postwar readjustment period with its heavy demand for the food and goods necessary for reconstruction and increased maintenance. After the removal of price controls, prices for farm products advanced to even higher levels than during the war.

Farm production during the war and postwar years was maintained at substantially higher levels than those that prevailed in prewar years. Consequently, gross farm incomes moved upward more rapidly than did the prices for farm products. Costs of farm operation also rose, but they did not rise so rapidly as prices or as incomes, so there was a very rapid advance in the net incomes that remained for the farm families.¹¹

With their higher incomes, farmers could buy many kinds of home appliances and farm equipment that previously had been beyond their means. Furthermore, they were learning the potentialities of such devices in saving labor indoors and out and were learning how to use them satisfactorily. Consequently, the average consumption of electric energy on the farms studied increased year by year, as did net incomes of Iowa farms (table 5).

To be fully understood, these data (on the consumption of electricity) must be examined in the light of the economic setting. Just what part of the increased consumption was due to secular influences and what part to wartime conditions is a matter for speculation as similar kinds of data, covering a period of falling prices and shrinking incomes, are not now available.

The average amount of energy used by electrified farms of this country east of the 100th meridian has increased annually, with few exceptions, for the last 18 years.¹² The trend abated somewhat at the depth of the depression in 1932 and 1933, but still the upward trend for the region as a whole was conspicuous even before World War II. There can be

TABLE 5.—Consumption of electric energy per farm on sample farms electrified 5 years or more, and operators' net cash farm incomes from hog-and beef-fattening farms, Iowa, 1938-1947

Year	Kilowatt-hours consumed	Operators' net cash farm income ¹
	Number	Dollars
1938.....	893	715
1939.....	1,024	855
1940.....	1,109	749
1941.....	1,228	1,799
1942.....	1,316	2,674
1943.....	1,519	4,204
1944.....	1,546	3,760
1945.....	1,691	4,236
1946.....	1,917	4,652
1947.....	2,551	8,152

¹ See footnote 11 below.

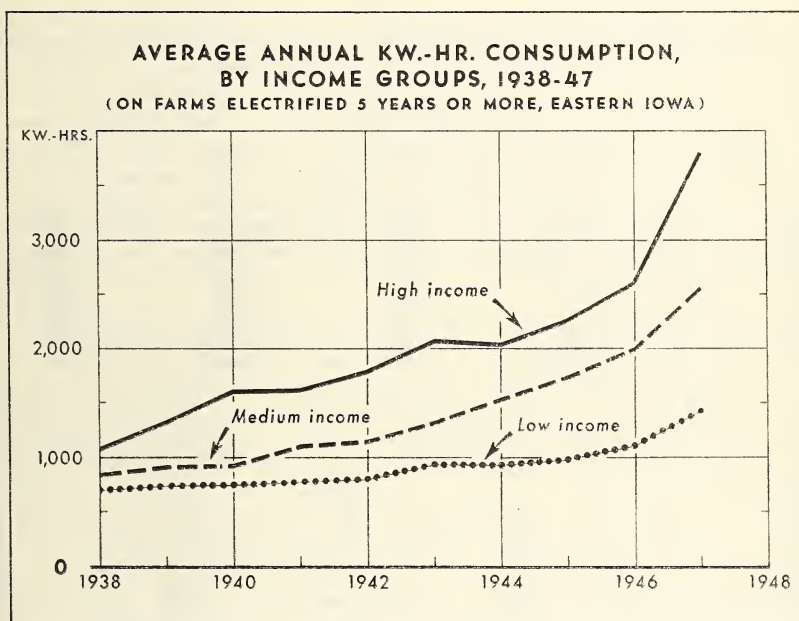
¹¹ For greater detail see GOODSSELL, WYLIE D., JONES, RONALD W., and BIERMAN, RUSSELL W. TYPICAL FAMILY-OPERATED FARMS, 1930-45, ADJUSTMENTS, COSTS AND RETURNS. Bur. Agr. Econ., F. M. 55, 91 pp., illus. 1946. [Processed.], and GOODSSELL, WYLIE D. FARM COSTS AND RETURNS, 1945-47, COMMERCIAL FAMILY-OPERATED FARMS IN 6 MAJOR FARMING REGIONS. Bur. Agr. Econ., F.M. 70, 18 pp., illus. 1948. [Processed.]

¹² UNITED STATES DEPARTMENT OF AGRICULTURE. AGRICULTURAL STATISTICS, 1948. Washington, U. S. Govt. Print. Off. 1949, table 692, page 614.

little doubt, however, that in eastern Iowa the upward trend in consumption was accelerated by the upsurge in farm income that accompanied the war and postwar periods.

INCREASE IN FARMERS' INCOMES

Approximate gross farm incomes (gross receipts) and incomes from off-farm sources were obtained for 1947, for each electrified farm included in the study. Incomes in that year were high; they had been increasing for several years. There was a conspicuous difference, however, between the rates of increase in the use of electricity on the farms of high, medium, and low total incomes.¹³ Of the farms that had been electrified 5 years or more, those with high incomes used $3\frac{1}{2}$ times as many kilowatt-hours on the average in 1947 as in 1938. The medium-income farms averaged three times as many kilowatt-hours at the end of the decade as at the beginning, while the low-income farms only doubled the amount used per farm (fig. 3).



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FIGURE 3.—High-income farms were using 250 percent more electric energy in 1947 than they used in 1938, whereas low-income farms had increased their average consumption during that period by about 100 percent.

The term "low-income farms" as used here refers to approximately a fourth of the farms in this survey, or those having total incomes of less than \$6,000 in 1947. "Medium-income farms" refers to those having total incomes of at least \$6,000 but less than \$15,000 in 1947, or

¹³ Total income refers to total income of the operator whether from farm or non-farm sources, minus the amount paid for livestock sold during the year.

approximately half of the farms. "High-income farms" are the remainder, or those with total incomes of \$15,000 or more in 1947.

In kilowatt-hours, the low-income farms that had been electrified 5 or more years, increased their average consumption from 692 in 1938 to 1,422 in 1947. The medium-income farms increased their consumption from 833 to 2,557, and the high-income farms from 1,073 to 3,800 (table 6). The average rate of annual increase for the low-income farms was 7.2 percent, for the medium-income farms 12.8 percent, and for the high-income farms 12 percent.¹⁴ Thus the differences between the income groups in the amount of electric energy used became larger during the decade.

In 1938, the medium-income farms that had been electrified for 5 or more years used 20 percent more kilowatt-hours than did the low-income farms, while the high-income farms used 29 percent more than those of medium income. By 1947, the difference between the groups had increased to 80 and 49 percent, respectively. The high-income farms used 55 percent more electricity in 1938 than did the low-income farms; by 1947 this spread had increased to 167 percent.

TABLE 6.—Consumption of electric energy per farm on farms electrified for 5 years or more by 1947 income groups, 1938-1947

Year	Income group ¹			All farms
	Low	Medium	High	
	<i>Kw.-hrs.</i>	<i>Kw.-hrs.</i>	<i>Kw.-hrs.</i>	<i>Kw.-hrs.</i>
1938.....	692	833	1,073	893
1939.....	729	907	1,324	1,024
1940.....	746	920	1,614	1,109
1941.....	773	1,101	1,619	1,228
1942.....	795	1,144	1,792	1,316
1943.....	937	1,309	2,069	1,519
1944.....	926	1,527	2,040	1,546
1945.....	975	1,735	2,258	1,691
1946.....	1,108	1,996	2,605	1,917
1947.....	1,422	2,557	3,800	2,551
Farms represented				
	Number	Number	Number	Number
1938.....	6	25	15	46
1939.....	6	26	16	48
1940.....	10	29	18	57
1941.....	14	33	27	74
1942.....	17	45	35	97
1943.....	22	57	45	124
1944.....	43	83	57	183
1945.....	61	116	68	245
1946.....	78	138	76	292
1947.....	87	149	78	314

¹ Low-income—Less than \$6,000 total income. Medium-income—\$6,000 to \$14,999. High-income—\$15,000 and over. "Total income" refers to the total income of the operator, whether from farm or nonfarm sources, minus the amount paid for livestock sold during the year.

It is to be noted that these farms were classified on the basis of 1947 incomes only. No information as to earlier incomes is available. It is probable that some farms in the high-income group would have been classified as medium or low income a few years earlier. On the

¹⁴ Calculated regression equations $Y_c = 650.4 (1.072^x)$; $Y_c = 764.3 (1.128^x)$ and $Y_c = 1,145.6 (1.12^x)$. For all three equations, 1938=0. Y_c is the calculated kilowatt-hours and x is the number of years after 1938.

other hand, a few farms in the low-income group might have been classified at some other time as having medium or high incomes. It is also probable that such farms are a minority and that most of them would have classifications similar to those of the present if data for the decade were available. But because of these exceptions, the indicated increases should be considered as broad tendencies rather than as accurate measurements.

INCREASE IN FARMERS' USE OF ELECTRICAL EQUIPMENT

In 1938, about 52 percent of all the electric energy used by all farms in the study was used for lighting the dwellings and the farm service buildings. In 1947, only 18 percent of the total was used for farm lighting.

This large percentage decrease was not caused by a decrease in the amount of electricity used for lighting but rather by a large increase in its use for operating home and farm equipment and appliances. For example, the average amount of electricity used for lighting in 1947 probably was about the same as it was in 1938, but the amount used for other purposes had increased from about 390 kilowatt-hours in 1938 to about 1,780 in 1947. Thus, there was an increase of nearly 1,400 kilowatt-hours per farm for the operation of equipment and appliances. Most of this increase was probably brought about by new purchases.

An inventory of the equipment and appliances used on these farms in 1938 is difficult to obtain because it must be reconstructed from the memories of people now on the farms. However, farmers appeared to remember fairly well the year in which their major appliances had been installed.

Data obtained in the study indicate the approximate increases in some of the items of equipment which are responsible for much of the increased consumption of electric energy. The proportion of farms with electric ranges increased from about 4 percent of all electrified farms in 1938 to 27 percent in April 1948, while the proportion of farms with electric refrigerators increased from 30 to 80 percent. Those with electric water heaters increased from about 4 to 23 percent, and with pressure water systems from approximately 25 to 48 percent. No farm in the sample reported electric-powered milking machines in 1938 but more than one-fifth of all electrified farms reported having them in April 1948. About 13 percent had electrically powered tool grinders in 1938, compared with 37 percent when the survey was made. Other kinds of shop tools using electric power increased in about the same proportion. About 18 percent of the electrified farms in 1938 had cream separators with electric motors; by 1947, 60 percent had this labor-saving device.

The freezer cabinet was an appliance that was not used in 1938 on any of the farms in the sample. By April 1948, it was in use on about 10 percent of the farms that were electrified. No information concerning the time of acquisition of electric washing machines was obtained, but by 1948, more than 90 percent of the farms had them.

A complete listing of the appliances in use in 1948 on the older and newer electrified farms, and on all farms in the sample, is shown for the

items mentioned above and for most of the other items reported (table 7). In general, the older electrified farms had more electrical equipment than the newer, just as the older ones used more electricity than the newer, (see page 14). This is particularly true in regard to some of the more expensive items. For instance, in April 1948, pressure water systems were reported on 58 percent of the older electrified farms and on 27 percent of the newly electrified farms. Electric ranges were found on 33 percent of the older electrified farms and on 15 percent of the newer.

On the other hand, some of the more popular pieces of electrical equipment were bought soon after the farms were electrified. Washing machines, radios, and electric irons were reported for about 91 to 99 percent of the older and newer electrified farms. About 99 washing machines, 146 radios, and 108 irons were reported for each 100 electrified farms. Some of these farms had more than one dwelling, which increased the number of some items per 100 farms. Electric cream separators, pig brooders, and brooder hovers, were reported in large numbers on both the older and newer electrified farms.

TABLE 7.—Percentage of farms using specified electrical equipment and pieces of equipment per 100 farms by period of electrification, April, 1948

Item	Farms reporting equipment and electrified			Equipment per 100 farms electrified		
	After Jan. 1 1943	Before Jan. 1 1943	Before Jan. 1 1947	After Jan. 1 1943	Before Jan. 1 1943	Before Jan. 1 1947
Farms represented.....	Number 147	Number 314	Number 461	Number	Number	Number
Household appliances: ¹	Percent	Percent	Percent			
Refrigerator.....	68.7	85.7	80.3	70.7	91.7	85.0
Range.....	15.0	32.8	27.1	15.0	34.4	28.2
Water heater.....	6.1	31.2	23.2	6.1	33.1	24.5
Freezer cabinet.....	7.5	10.5	9.5	7.5	11.5	10.2
Washing machine.....	91.8	91.1	91.3	94.6	101.0	98.9
Radio.....	95.2	98.4	97.4	121.1	158.3	146.4
Iron.....	98.6	98.1	98.3	103.4	110.2	108.0
Clock.....	56.5	72.0	67.0	73.5	106.0	95.7
Toaster.....	75.5	79.3	78.1	76.9	85.7	82.9
Vacuum cleaner.....	49.0	75.5	67.0	50.3	82.2	72.0
Household fan.....	32.7	55.7	48.4	32.7	72.9	60.1
Food mixer.....	19.0	44.9	36.7	19.0	46.2	37.5
Heat pad.....	17.0	38.9	31.9	17.0	42.4	34.3
Hot plate.....	31.3	39.8	37.1	33.3	41.7	39.0
Waffle iron.....	25.2	43.0	37.3	25.2	45.5	39.0
Space heater.....	6.8	25.5	19.5	6.8	26.8	20.4
Sewing machine.....	7.5	16.6	13.7	7.5	16.6	13.7
Percolator.....	4.8	12.1	9.8	5.4	13.1	10.6
Roaster.....	3.4	7.3	6.1	3.4	7.3	6.1
Ironer.....	2.7	5.7	4.8	2.7	6.1	5.0
Coal stoker.....	1.4	8.3	6.1	1.4	8.3	6.1
Oil furnace.....	2.7	7.6	6.1	2.7	8.0	6.3
Hot-air fan.....	12.2	18.5	16.5	12.2	18.8	16.7
Hot-water pump.....	.7	2.2	1.7	.7	2.2	1.7
Air-conditioning unit.....	.7	1.0	.9	.7	1.0	.9
Blanket.....	1.4	2.2	2.0	1.4	2.9	2.4
Broiler.....	2.0	2.5	2.4	2.0	2.5	2.4
Ventilating fan.....		1.6	1.1		1.6	1.1
Ice-cream freezer.....		1.6	1.1		1.6	1.1
Water systems:						
Pressure system.....	27.2	58.0	48.2	30.6	72.3	59.0
Gravity system.....	4.1	12.7	10.0	4.8	14.0	11.1
Pump jack.....	36.1	35.4	35.6	38.8	37.9	38.2

¹ Does not include a few appliances such as grills, hair clippers, heat lamps, meat grinders, corn poppers, record players, and vaporizers found on some farms.

TABLE 7.—*Percentage of farms using specified electrical equipment and pieces of equipment per 100 farms by period of electrification, April, 1948—Continued*

Item	Farms reporting equipment and electrified			Equipment per 100 farms electrified		
	After Jan. 1 1943	Before Jan. 1 1943	Before Jan. 1 1947	After Jan. 1 1943	Before Jan. 1 1943	Before Jan. 1 1947
Farm shop equipment:	<i>Percent</i>	<i>Percent</i>	<i>Percent</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>
Air compressor.....	7.5	16.6	13.7	7.5	16.6	13.7
Drill press.....	4.1	18.2	13.7	4.1	18.5	13.9
Portable drill.....	7.5	10.2	9.3	7.5	10.5	9.5
Tool grinder.....	26.5	42.0	37.1	27.2	44.6	39.0
Power saw.....	3.4	13.1	10.0	3.4	14.6	11.1
Welder.....	3.4	10.8	8.5	3.4	11.1	8.7
Battery charger.....	.7	6.7	4.8	.7	7.0	5.0
Lathe.....	-----	3.5	2.4	-----	3.5	2.4
Forge.....	-----	1.3	.9	-----	1.3	.9
Concrete mixer.....	4.8	3.5	3.9	4.8	3.5	3.9
Soldering iron.....	12.2	27.7	22.8	12.2	30.3	24.5
Dairy equipment:						
Cream separator.....	61.2	59.2	59.9	61.2	59.6	60.1
Milking machine.....	16.3	22.6	20.6	17.0	23.2	21.3
Water heater.....	3.4	5.1	4.6	3.4	5.1	4.6
Ventilator fan.....	.7	2.2	1.7	.7	2.5	2.0
Churn.....	-----	2.2	1.5	-----	2.2	1.5
Milk cooler.....	-----	.6	.4	-----	.6	.4
Livestock equipment:						
Pig brooder.....	17.0	12.1	13.7	62.6	73.9	70.3
Tank heater.....	4.8	13.1	10.4	6.1	17.5	13.9
Fence controller.....	5.4	9.9	8.5	5.4	10.8	9.1
Stock clipper.....	2.0	1.6	1.7	2.0	1.6	1.7
Poultry equipment:						
Brooder hover.....	36.0	41.7	39.9	36.7	45.5	42.7
Brooder-battery.....	-----	.6	.4	-----	.6	.4
Water warmer.....	15.6	19.1	18.0	17.7	27.7	24.5
Other farm equipment:						
Grain elevator.....	3.4	12.4	9.5	3.4	13.1	10.0
Corn sheller.....	4.8	8.0	6.9	4.8	8.0	6.9
Seed cleaner.....	4.1	8.3	6.9	4.1	8.3	6.9
Feed grinder.....	.7	1.3	1.1	.7	1.3	1.1
Grain drier.....	-----	.3	.2	-----	.3	.2
Hay hoist.....	-----	.3	.2	-----	.3	.2

CHANGE IN SEASONAL CONSUMPTION PATTERN

Seasonal patterns of consumption have changed with the increased use of electricity through the years. Practically all of the months when consumption was high and those when it was low, during 1947, were in reverse order from the pattern found only 7 years earlier. The variations between the seasons were even more pronounced.

During the first 5 months of 1940 the average amount of electricity used on all farms gradually declined. It dropped from 78 kilowatt-hours in January to 59 kilowatt-hours in May, which was the low point for the year. There was a substantial pick-up in June, July, and August; an average of 74 kilowatt-hours were used in both July and August. A small let-down to 68 and 69 kilowatt-hours, respectively, came in September and October. Consumption increased again to 76 kilowatt-hours in both November and December—just under the January peak. The spread between the high- and low-consumption months of the year was only 19 kilowatt-hours (table 8).

In 1947 the seasonal pattern had changed considerably. Throughout that year consumption was at a much higher level and the average

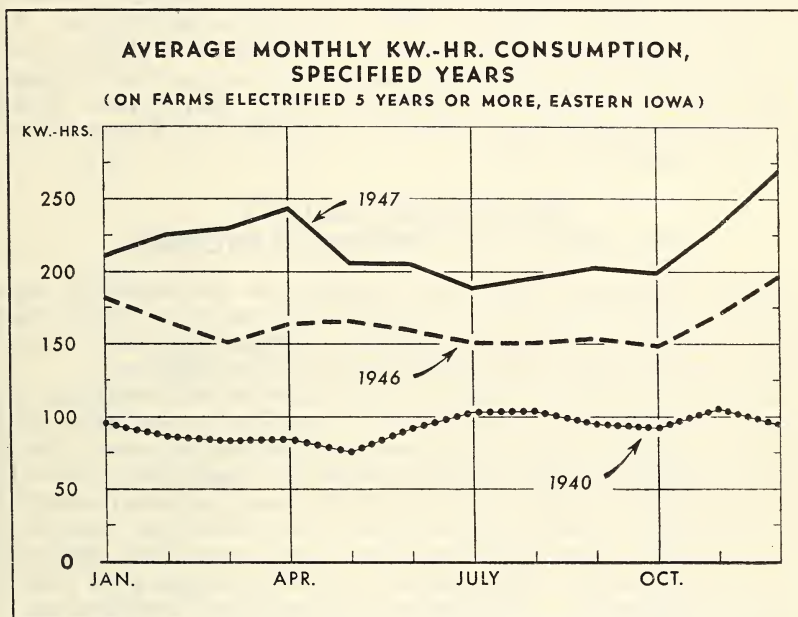
TABLE 8.—Consumption of electric energy per farm on the older and newer electrified farms, and on all farms by months, 1940, 1946, and 1947

Item	Electrified 5 years or more in —			Electrified less than 5 years in —			All farms in —		
	1940	1946	1947	1940	1946	1947	1940	1946	1947
Farms represented ¹	Number 55	Number 265	Number 285	Number 127	Number 135	Number 131	Number 182	Number 400	Number 416
	<i>Kw.-hrs.</i> 96	<i>Kw.-hrs.</i> 182	<i>Kw.-hrs.</i> 211	<i>Kw.-hrs.</i> 67	<i>Kw.-hrs.</i> 105	<i>Kw.-hrs.</i> 117	<i>Kw.-hrs.</i> 78	<i>Kw.-hrs.</i> 158	<i>Kw.-hrs.</i> 182
January.....	87	165	225	59	94	114	68	143	190
February.....	83	151	229	53	94	110	63	133	191
March.....	84	163	243	55	93	124	64	140	206
April.....	76	166	206	51	90	111	59	141	176
May.....	92	159	206	58	109	113	69	142	177
June.....	103	151	188	62	82	103	74	128	161
July.....	103	151	196	63	83	112	74	127	170
August.....	95	153	202	58	86	107	68	129	172
September.....	92	148	199	60	85	112	69	126	172
October.....	105	170	231	66	100	130	76	145	199
November.....	94	197	269	69	122	153	76	170	232
December.....									
Total.....	1,110	1,956	2,605	721	1,143	1,406	838	1,682	2,228
Monthly average.....	92	163	217	60	95	117	70	140	186

¹ Numbers of farms are not comparable with those shown in tables showing annual consumption because the meters on some farms were read quarterly rather than monthly.

amount of electric energy used per month increased from 182 kilowatt-hours in January to 206 kilowatt-hours in April. Through the summer the amount used held fairly constant, ranging from 177 kilowatt-hours in June to 161 in July. In the last 2 months of the year use increased rapidly. The average amount in December was 232 kilowatt-hours or 50 kilowatt-hours more than in the preceding January. The spread between the high- and low-consumption months was 71 kilowatt-hours.

Seasonal variations in the use of electricity by farms that had had electricity for 5 or more years were similar to the seasonal variations for all farms, but total consumption was at a much higher level (table 8). These seasonal variations for the older electrified farms, and the level of consumption for each year, 1940, 1946, and 1947, are shown in figure 4.



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FIGURE 4.—The seasonal pattern of the use of electricity has changed over the years and the monthly and annual consumption per farm has increased. Peaks of consumption now occur in winter and spring; but in 1940 consumption was relatively heavy in summer, fall, and winter.

Some of the differences in consumption, in various months, may be accounted for by the seasonal use of certain equipment. The high consumption in the late winter and early spring of 1947 was probably strongly influenced by the widespread use of electric pig brooders, chick brooders (hover type), and tank heaters. In addition to those already in use, 49 pig brooders and 17 brooder hovers were installed in 1947 on the 314 farms that had been electrified for 5 or more years. These appliances are relatively new to farms in this area. None of the farms reported having pig brooders before 1942 or chick brooders before 1938.

Some of the differences were due to the increase in the number of electrical devices used. The energy used in the last 3 or 4 months of 1947 was undoubtedly increased by the use of equipment that was installed during the year.

Following is a partial list of new electrical equipment installed in 1947 on the 314 farms that had been electrified before January 1, 1943; 34 water heaters (in dwellings), 32 ranges, 46 refrigerators, 20 freezer cabinets, 12 milking machines, 24 cream separators, and 15 tank heaters.

This equipment would use enough energy to average about 43 kilowatt-hours a month for the 314 farms in the group. In other words, the average consumption in December 1947 would have been about 43 kilowatt-hours higher than in the preceding January, solely because of the use of the indicated equipment bought in 1947. Average consumption by these 314 older electrified farms was 58 kilowatt-hours higher in December 1947 than in January 1947. It is apparent, therefore, that most of this difference may be accounted for by the addition of new equipment rather than by seasonal use of equipment already installed.

The dates of acquisition of small appliances—heating pads, radios, and food mixers—were not obtained, but undoubtedly a large number of these were installed in 1947.

USE OF ELECTRICITY ON FARMS OF DIFFERENT INCOMES

Family income has long been recognized as an influential factor affecting family expenditures. Consideration was given in this study, therefore, to the extent to which the use of electricity in 1947 on farms in this area was related to the total incomes of the operators.

The term "total income" as used in this publication refers to the total income of the operator in 1947, whether from farm or nonfarm sources, minus the amount paid for livestock sold during the year. No deduction is made for feed or fertilizer bought, for wages paid, or for other farm expenses, and no allowance is made for changes in farm inventories. Nonfarm income includes such items as wages received for work off the farm, rents from land rented to others, net income from businesses conducted off the farm, total amount received for custom work done for others, and pensions. It includes, in some cases, contributions to family living from other members of the household.

By the definition here used total income is a rough measure of the size of the business and of the disposable income rather than a precise statement of financial affairs in a strict accounting sense. As a rule, the farms that had high incomes were larger business enterprises than those with low incomes. The high-income farms averaged more acres of land, had more crop acres, and produced more livestock than those with low incomes (table 9).

There were exceptions to the rule. As the incomes reported are for the year 1947 only, they were relatively high for some farms and relatively low for others. For instance, some farms sold more livestock than usual in 1947 and their incomes were relatively high. On the contrary, a few farms had almost complete crop failures because of floods, and their incomes were unusually low. For most farms, however, the farm organization in 1947 was similar to that of 1946 and 1945, and probably did not change much in 1948. The total income multi-

TABLE 9.—*Characteristics of electrified farms, by income groups, 1947*

Characteristic	Unit	Income group						All farms
		Under \$4,000	\$4,000– 5,999	\$6,000– 9,999	\$10,000– 14,999	\$15,000– 19,999	\$20,000 and over	
Farms represented.....	Number.....	72	68	123	104	37	57	461
Electricity consumed.....	Kw.-hr.....	1,264	1,328	1,863	2,533	3,098	3,747	2,174
Acreage operated.....	Acre.....	62	98	145	180	253	330	165
Acreage in crops.....	do.....	33	60	96	126	184	212	109
Income:								
Gross farm.....	Dollar.....	1,671	4,050	7,536	11,253	16,705	26,113	9,977
Off-farm.....	do.....	993	1,003	456	661	419	1,005	732
Total income.....	do.....	2,664	5,053	7,992	11,914	17,124	27,118	10,709
Animal units ¹	Number.....	9.7	20.9	35.0	45.3	60.8	96.9	41.0
Farms:								
Type:								
Hog.....	do.....	13	32	77	63	23	34	242
Beef-hog.....	do.....	5	1	12	13	3	13	47
Cash-crop.....	do.....	9	8	14	12	9	7	59
General ²	do.....	13	19	17	14	2	2	67
Noncommercial ³	do.....	32	8	3	2	—	1	46
Tenure:								
Full owner.....	do.....	49	40	67	41	7	20	224
Part owner.....	do.....	2	5	11	13	15	17	63
Tenant.....	do.....	21	23	45	50	15	20	174
Multiple dwelling:								
Two wired.....	do.....	—	1	4	10	9	21	45
Three wired.....	do.....	—	—	—	—	1	1	2

¹ See table 52 p. 88, for factors used.² Includes 57 general farms, 4 poultry farms, and 6 dairy farms.³ Includes 31 farms producing mainly for household use and 15 rural residences.

plied by the number of farms, therefore, gives a reasonably satisfactory measure of the size of the farm business.

The size of the farm business is important from the viewpoint of electrification because of its possible effect on the opportunities to use electrical equipment in the business. Disposable income is important because of its effect on the amount that can be spent for family living and consequently its effect on the installation and use of electrical equipment in the homes.

The income of the farms studied as a whole was preponderantly from agricultural sources. More than 93 percent of the total income of the 461 farms in the sample was derived from the sale and home use of agricultural products. For some individual tracts, however, the nonfarm income was important. Most of these were in the low-income groups. For example, in 1947, 72 tracts had total incomes of less than \$4,000, almost two-fifths of which came from the farm. Most of the tracts having a large part of their incomes from nonfarm sources were occupied by part-time or retired farmers or laborers. In this section of the report all farms are considered together regardless of type. The influence of type of farm on the use of electric energy is considered later.

CONSUMPTION OF ELECTRIC ENERGY

There was a direct relation between the total incomes of farms in this area in 1947 and the kilowatt-hours of electric energy used that year. The higher the total income of the operator, the greater was the average amount of electricity used.¹⁵

This does not imply that the higher income was the sole cause for the increased use of electricity. It does indicate that the higher incomes, in combination with all the characteristics associated with them, resulted in the greater use. Because they were larger businesses, the farms with high incomes offered more opportunities for the use of electrically powered equipment. Furthermore, the farms with higher incomes had more wired dwellings per farm than did the lower income farms. The larger number of occupied dwellings meant more families on the farms and a greater need for household appliances and for home lighting. Of the 72 farms with total incomes in 1947 of less than \$4,000, none had more than one occupied dwelling. Above this income group the number of wired dwellings per farm gradually increased—101 dwellings per 100 farms in the \$4,000–\$5,999 total income group; 103 in the \$6,000–\$9,999 group; 110 in the \$10,000–\$14,999 group; 130 in the \$15,000–\$19,999 group; and 140 wired dwellings per 100 farms in the \$20,000 and over group. Service buildings also were more numerous on the farms that had higher incomes.

Of the farms electrified for 5 years or more (the older electrified farms) those with total incomes of less than \$4,000 in 1947, used an average of 1,311 kilowatt-hours during the year. Each successively higher income group used more electricity than the preceding one until finally in the total income group of \$20,000 and over, the average amount used was 4,055 kilowatt-hours (table 10).

¹⁵ Two regression equations were calculated of 1947 kilowatt-hour consumption on 1947 income for the 314 farms electrified 5 years or more. The resulting equation in one case was $Y_c = 1176 + .11812X$ with a coefficient of correlation, $r = .4658$. In the other the equation was $\text{Log } Y_c = 1.33034 + .493368 (\text{Log } X)$ and $r = .5013$. In both equations Y_c is the calculated kilowatt-hours and X is the income in dollars.

TABLE 10.—*Characteristics of farms electrified before January 1, 1943, by income groups, 1947*

Characteristic	Unit	Income group					All farms
		Under \$4,000	\$4,000- 5,999	\$6,000- 9,999	\$10,000- 14,999	\$15,000- 19,999	\$20,000 and over
Farms represented.....	Number.....	46	41	70	79	29	314
Electricity consumed.....	Kw.-hr.....	1,311	1,517	2,249	2,846	3,369	2,551
Acreage operated.....	Acre.....	46	88	138	179	256	169
Acreage in crops.....	do.....	27	52	94	125	188	114
Income:							
Gross farm.....	Dollar.....	1,604	3,827	7,218	11,246	16,492	10,765
Off-farm.....	do.....	1,037	1,263	646	779	532	874
Total income.....	do.....	2,641	5,090	7,864	12,025	17,024	11,639
Animal units.....	Number.....	8.4	18.9	33.1	45.1	59.1	42.5
Farms:							
Type:							
Hog.....	do.....	8	20	39	47	17	161
Beef-hog.....	do.....	3	1	12	10	2	38
Cash-crop.....	do.....	5	5	5	9	9	39
General 1.....	do.....	7	8	11	11	1	40
Noncommercial 2.....	do.....	23	7	3	2	---	36
Tenure:							
Full owner.....	do.....	33	28	43	34	5	160
Part owner.....	do.....	1	2	8	10	14	49
Tenant.....	do.....	12	11	19	35	10	105
Multiple dwelling:							
Two wired.....	do.....	---	---	3	9	9	39
Three wired.....	do.....	---	---	---	---	1	2

¹ Includes 35 general farms, 3 poultry farms, and 2 dairy farms.² Includes 25 farms producing mainly for household use and 11 rural residences.

Farms electrified for less than 5 years, or those newly electrified, exhibited the same tendency; that is, the farms with higher incomes used the greater amounts of electricity. But this tendency was less consistent and less marked than was true of the farms that had been electrified for 5 years or more (table 11). The irregularities in increases of consumption among the various income groups of newly electrified farms probably were partly due to the smallness of the sample and to the heterogeneous nature of this group of farms. Some were in their first year of electrification; others had used the service for only 2, 3, or 4 years.

One conspicuous difference was disclosed between the newly electrified and the old electrified farms of different income groups. In the lower income groups the newly electrified farms used almost as much energy as the older electrified farms, but in the upper income groups the more recently electrified farms used only about half as much electricity as those electrified 5 years or more. Thus, the newly electrified farms with less than \$4,000 total income in 1947 used 90 percent as much electricity as the older electrified farms with similar incomes. In the \$4,000-\$5,999 income group the newly electrified farms used 69 percent as much as the older electrified ones, but in the \$20,000 and over groups they used only 46 percent as much.

These data suggest that after 5 years of electrification the large farms may install electrical appliances and motor-driven equipment much more rapidly than the small ones but that in the first 5 years of electrification there may be less difference in the rates at which the devices are acquired.

NUMBER OF BUILDINGS AND AMOUNT OF LIGHTING

The more universal use of electricity on farms in this area was for lighting—in dwellings, service buildings, and service areas. An abundance of light at the snap of a switch has added so much to the satisfaction of farm living that electric lights are now considered by practically everyone as a necessity. A large proportion of the interviewed farmers volunteered the belief that they could get along without electricity for everything except lights. On most farms, all the principal buildings were wired for lights when electric service was first received. Only a few were wired several years after the farms were electrified.

Although lighting was considered by the farmers to be the most valuable single use they made of electricity, the amount of electric energy used for lighting amounted to only about 18.3 percent of the total used on the farms, in 1947. Lighting on the newly electrified farms accounted for about 26 percent of the total consumption and on the older electrified farms for about 16 percent.

The newly electrified farms used almost as many kilowatt-hours of electricity for lighting as the older electrified ones, but as they had less electrical equipment the proportionate amount used for lighting was greater on them.

Estimates of the average use of electricity per building in 1947 show that the lighting of dwellings alone accounted for 315 kilowatt-hours, or 14.5 percent of the 2,174 kilowatt-hours of total average consumption of the 461 farms. House lighting accounted for 20 percent of total consumption for the newly electrified farms and 13 percent for the

TABLE 11.—*Characteristics of farms electrified after January 1, 1943, by income groups, 1947*

Characteristic	Unit	Income group						All farms
		Under \$4,000	\$4,000–5,999	\$6,000–9,999	\$10,000–14,999	\$15,000–19,999	\$20,000 and over	
Farms represented.....	Number.....	26	27	53	25	8	8	147
Electricity consumed.....	Kw.-hr.....	1,180	1,041	1,354	1,543	2,113	1,863	1,367
Acreage operated.....	Acre.....	91	115	154	182	243	328	155
Acreage in crops.....	do.....	44	73	98	129	168	193	98
Income:								
Gross farm.....	Dollar.....	1,788	4,389	7,956	11,277	17,478	26,353	8,294
Off-farm.....	do.....	914	607	206	288	9	564	428
Total income.....	do.....	2,702	4,996	8,162	11,565	17,487	26,917	8,722
Animal units.....	Number.....	12.0	23.9	37.6	45.8	67.1	113.6	37.7
Farm:								
Type:								
Hog.....	do.....	5	12	38	16	6	4	81
Beef-hog.....	do.....	2			3	1	3	9
Cash-crop.....	do.....	4	3	9	3		1	20
General 1.....	do.....	6	11	6	3	1		27
Noncommercial 2.....	do.....	9	1					10
Tenure:								
Full owner.....	do.....	16	12	24	7	2	3	64
Part owner.....	do.....	1	3	3	3	1	3	14
Tenant.....	do.....	9	12	26	15	5	2	69
Multiple dwelling: Two wired.....	do.....		1	1	1		3	6

¹ Includes 22 general farms, 1 poultry farm, and 4 dairy farms.² Includes 6 farms producing mainly for household use and 4 rural residences.

older. All the farms in the survey had at least one dwelling wired, 45 had 2, and 2 had 3 wired dwellings. Of the 513 dwellings on the 461 farms, only 3 were not wired (table 12).

Lighting all of the farm service buildings, including yards, required only about a fourth as much electricity as lighting all of the dwellings. Not all of the service buildings were wired; and those that were wired used much less energy per building for lighting than did the dwellings. In general, there were few light bulbs in the service buildings, the bulbs were of a low wattage, and they were lighted for only a short time each day.

In the aggregate, poultry houses required more energy for lighting than any other one kind of service building on the farms. Eighty-seven percent of the farms had at least one poultry house and almost two-thirds of these buildings were wired. Lights in the poultry houses burned for many hours each day on many farms, especially during the winter.

In the aggregate, general barns used almost as much electricity for lighting as poultry houses. There were a few more general barns than poultry houses, 444 of one and 422 of the other, and more of them were wired—89 percent compared with 66 percent—but the use per barn probably was only about two-thirds as much as the use per poultry house.

The amount of energy required to light a poultry house, a dairy barn, or a milk house, was estimated to be about the same. As only 109 milk houses and 37 dairy barns were wired the total electricity used by them was considerably less than the total used by poultry houses.

Two-fifths of the farm shops were in separate buildings, and four-fifths of those buildings were wired for electricity. Wiring in the shops provided outlets for lights and for electrically powered shop tools. On an occasional farm the shop was a corner of the implement shed or a part of the garage. Almost three-fourths of the farms had a garage and two-thirds of these garages were wired.

More than three-fourths of the farms had corn cribs or grain-storage buildings. Only a little more than half of these buildings were wired. The principal reason given by farmers for not wiring them was that they were used very little at night.

There were hog houses of a permanent type on 70 percent of the farms. Less than 60 percent of these houses were wired. Usually, lights burned in these buildings only a few hours in a year, so the total energy used to light them was only about four-tenths of one percent of the amount required to light the farm dwellings.

High-income farms as a group reported more of every kind of permanent building and a larger proportion of the service buildings wired than did the low-income farms. The high-income farms were larger business enterprises, had more livestock and more machinery, and so had more need for the improvements than did the low-income farms. The medium-income farms were usually about midway between these groups in regard to the number of buildings reported and the proportion of those buildings that were wired.

High-income farms had an average of 9.4 permanent buildings per farm; medium-income, an average of 7.7, and low-income, an average of 5.9. In number of buildings wired for electricity a still greater relative difference was found between the income groups. The high-

TABLE 12.—Number of farms and buildings and percentage of buildings wired, by 1947 income groups and kind of buildings, April 1948¹

Item	Low-income farms					Medium-income farms				
	Buildings			Wired		Buildings			Wired	
	With buildings ²	Total	Number	Total	Percentage	With buildings ²	Total	Number	Total	Percentage
Dwelling.....	140	141	141	141	100.0	227	244	241	241	98.8
General barn.....	122	124	124	99	79.8	209	218	199	199	91.3
Dairy barn.....	7	7	7	5	71.4	22	22	20	20	90.9
Beef barn.....	11	11	11	2	18.2	42	44	21	21	47.7
Hog house.....	77	84	84	33	39.3	177	200	116	116	58.0
Poultry house.....	112	112	112	67	59.8	205	211	144	144	68.2
Brooder house.....	75	77	77	45	58.4	172	184	138	138	75.0
Milk house.....	25	25	25	23	92.0	71	72	67	67	93.1
Crib and granary.....	80	87	87	46	52.9	186	205	107	107	52.2
Garage.....	83	83	83	53	63.9	171	177	115	115	65.0
Shop.....	42	42	42	37	88.1	101	105	83	83	79.0
Cave.....	15	15	15	10	66.7	14	14	12	12	85.7
Other buildings ³	20	22	22	20	90.9	46	57	32	32	56.1
All farms										
Dwelling.....	94	128	128	128	100.0	461	513	510	510	99.4
General barn.....	91	102	102	95	93.1	422	444	393	393	88.5
Dairy barn.....	12	13	13	12	92.3	41	42	37	37	88.1
Beef barn.....	40	41	41	25	61.0	93	96	48	48	50.0
Hog house.....	73	85	85	62	72.9	327	369	211	211	57.2
Poultry house.....	86	99	99	67	67.7	403	422	278	278	65.9
Brooder house.....	65	79	79	58	73.4	312	340	241	241	70.9
Milk house.....	20	22	22	19	86.4	116	119	109	109	91.6
Crib and granary.....	84	112	112	67	59.8	330	404	220	220	54.5
Garage.....	76	86	86	57	66.3	330	346	225	225	65.0
Shop.....	54	56	56	49	87.5	197	203	169	169	83.3
Cave.....	8	8	8	8	100.0	37	37	30	30	81.1
Other buildings ³	36	52	52	35	67.3	102	131	87	87	66.4

¹ See footnote 1, table 6.² The number of farms represented in each group is the same as the number of farms with dwellings.³ Machine sheds, wash houses, tool sheds, etc.

income farms had 7.3 permanent buildings wired per farm, the medium-income 5.7, and the low-income 4.2. The income groups varied only a little in number of unwired buildings per farm, the range being from 2.1 for the high-income farms to 1.8 for farms of low income.

High-income farms had 35 percent more wired dwellings per 100 farms than did the low-income farms. Each 100 farms had 43 percent more general barns with electricity, $3\frac{1}{2}$ times as many wired dairy barns, almost 3 times as many wired hog houses, more than twice as many wired corn cribs and granaries, and twice as many shops that were wired.

Although not all farms in each income group reported yard lights, those with high incomes made the most extensive use of them. There was an average of 1.6 yard lights per high-income farm studied, compared with 1.3 for the medium-income farms, and 0.8 for those with low incomes (table 13). Based on estimated consumption, these yard lights used in the aggregate about 2 percent as much electricity as was used to light the farm dwellings.

USE OF ELECTRICAL EQUIPMENT IN FARMING

As a general rule, the first electrical equipment installed in a dwelling comprised an iron, a radio, and a washing machine. Next in order of purchase came a toaster, refrigerator, clock, and vacuum cleaner. Of the 147 newly electrified farms, 145 had at least one electric iron, 140 had a radio that used energy from the power line, and 135 had a washing machine driven by an electric motor. Electric toasters were found on 111 of these farms, 101 had electric refrigerators, 83 had at least one electric clock, and 72 had a vacuum cleaner. Therefore, 3 of the 7 most frequently found appliances—iron, washing machine, and vacuum cleaner—are devices that lighten the more arduous household tasks in many farm homes.

Other electric appliances found in considerable numbers on the newly electrified farms were household fans, hot plates, waffle irons, food mixers, and heat pads.

TABLE 13.—*Number and percentage of farms having yard lights, and number of lights by 1947 income groups, April 1948*

Item	Unit	Income groups			All farms
		Low	Medium	High	
Farms:					
Represented.....	Number..	140	227	94	461
With yard lights.....	-----do-----	95	197	77	369
With yard lights.....	Percent.....	67.9	86.8	81.9	80.0
Lights on farms.....	Number.....	111	292	147	550

The first piece of electrical equipment installed in appreciable numbers for use in the farm operations was the cream separator. More than 60 percent of the newly electrified farms had one. Milking machines also were added rather quickly; they were found on a sixth of these farms. More than a third had electric brooder hovers for

chicks and 16 percent had electric water warmers for poultry. About a fifth had electric brooders for pigs. More than a fourth had electric-driven tool grinders. Other shop tools and farm equipment—such as tank heaters, corn shellers, grain elevators, and seed cleaners—were installed but not in large numbers.

Among the newly electrified farms those with high incomes tended to have more electrical equipment than those with small incomes. They had more of the larger household appliances and more water systems and water pumps operated with electric motors. The low-income farms, however, had about as many of the other household appliances and farm equipment as the large farms (table 14).^{*} Nearly every farm had a radio and an electric iron. There was no apparent tendency in any of the income groups to acquire large numbers of electrical devices immediately after the farm was electrified.

TABLE 14.—Percentage of farms electrified after Jan. 1, 1943, using specified electrical equipment and pieces of equipment per 100 farms, by 1947 income groups, April 1948¹

Item	Farms reporting equipment			Equipment per 100 farms with		
	Low income	Medium income	High income	Low income	Medium income	High income
	Number	Number	Number	Number	Number	Number
Farms represented	53	78	16			
Household appliances:	Percent	Percent	Percent	Percent	Percent	Percent
Refrigerator	58.5	70.5	93.8	60.4	71.8	100.0
Range	11.3	16.7	18.8	11.3	16.7	18.8
Water heater	3.8	6.4	12.5	3.8	6.4	12.5
Freezer cabinet	5.7	5.1	25.0	5.7	5.1	25.0
Washing machine	84.9	94.9	100.0	84.9	96.2	118.8
Radio	96.2	94.9	93.8	107.5	123.1	156.2
Iron	98.1	98.7	100.0	100.0	101.3	125.0
Clock	49.1	65.4	37.5	62.3	85.9	50.0
Toaster	67.9	79.5	81.2	67.9	80.8	87.5
Vacuum cleaner	43.4	47.4	75.0	43.4	48.7	81.2
Household fan	30.2	37.2	18.8	30.2	37.2	18.8
Food mixer	7.5	23.1	37.5	7.5	23.1	37.5
Heat pad	5.7	23.1	25.0	5.7	23.1	25.0
Hot plate	24.5	38.5	18.8	24.5	42.3	18.8
Waffle iron	24.5	23.1	37.5	24.5	23.1	37.5
Space heater	11.3	5.1		11.3	5.1	
Sewing machine	3.8	10.3	6.2	3.8	10.3	6.2
Percolator	1.9	6.4	6.2	1.9	7.7	6.2
Roaster	3.8	3.8		3.8	3.8	
Ironer	1.9	3.8		1.9	3.8	
Coal stoker		2.6			2.6	
Oil furnace		3.8	6.2		3.8	6.2
Hot-air fan	7.5	15.4	12.5	7.5	15.4	12.5
Hot-water pump			6.2			6.2
Air-conditioning unit	1.9			1.9		
Blanket		2.6			2.6	
Broiler		2.6	6.2		2.6	6.2
Water systems:						
Pressure system	20.8	28.2	43.8	22.6	30.8	56.2
Gravity system		6.4	6.2		7.7	6.2
Pump jack	22.6	39.7	62.5	22.6	39.7	87.5
Farm shop equipment:						
Air compressor	7.5	7.7	6.2	7.5	7.7	6.2
Drill press	1.9	5.1	6.2	1.9	5.1	6.2
Portable drill	1.9	11.5	6.2	1.9	11.5	6.2
Tool grinder	15.1	34.6	25.0	17.0	34.6	25.0
Power saw	3.8	3.8		3.8	3.8	
Welder		6.4			6.4	
Battery charger		1.3			1.3	
Concrete mixer		9.0			9.0	
Soldering iron	11.3	14.1	6.2	11.3	14.1	6.2

TABLE 14.—Percentage of farms electrified after Jan. 1, 1943, using specified electrical equipment and pieces of equipment per 100 farms, by 1947 income groups April 1948¹—Continued

Item	Farms reporting equipment			Equipment per 100 farms with		
	Low income	Medium income	High income	Low income	Medium income	High income
Dairy equipment:	<i>Percent</i>	<i>Percent</i>	<i>Percent</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>
Cream separator.....	43.4	71.8	68.8	43.4	71.8	68.8
Milking machine.....	7.5	23.1	12.5	7.5	24.4	12.5
Water heater.....	3.8	3.8		3.8	3.8	
Ventilator fan.....		1.3			1.3	
Livestock equipment:						
Pig brooder.....	1.9	26.9	18.8	1.9	101.3	75.0
Tank heater.....	3.8	5.1	6.2	7.5	5.1	6.2
Fence controller.....	1.9	7.7	6.2	1.9	7.7	6.2
Stock clipper.....		3.8			3.8	
Poultry equipment:						
Brooder hover.....	28.3	42.3	31.2	30.2	42.3	31.2
Water warmer.....	13.2	19.2	6.2	13.2	23.1	6.2
Other farm equipment:						
Grain elevator.....		6.4			6.4	
Corn sheller.....	5.7	5.1		5.7	5.1	
Seed cleaner.....		7.7			7.7	
Feed grinder.....		1.3			1.3	

¹ See footnote 1, table 6.

As farmers have gained experience with electricity and electrical equipment, they have made more and more use of them. The tendency to install more electrical appliances and motor-driven equipment was especially noticeable among the farms of higher incomes. Among the farms that had been electrified 5 years or more the higher income groups had more of practically every electrical device. For example, 95 percent of the high-income farms had an electric refrigerator, compared with 76 percent of those with low incomes. Electric water heaters were in use on 41 percent of the high-income farms and on 25 percent of the low-income farms. Sewing machines driven by electricity were on 22 percent of the high-income farms and on 8 percent of the low-income farms (table 15).

Differences in numbers of appliances on farms of different income levels were even greater than differences in proportion of farms having those appliances. For instance, 95 percent of the farms with high incomes that had been electrified for 5 years or more had at least one electric refrigerator. In fact, there were 113 electric refrigerators per 100 farms. Apparently, almost a fifth of those farms that had electric refrigerators had two. At the same time, 76 percent of the low-income farms had an electric refrigerator but none had more than one. A similar condition prevailed with respect to many other household appliances. It is to be remembered that the large farms had more wired dwellings and that an appliance could be used in each dwelling.

TABLE 15.—Percentage of farms electrified before Jan. 1, 1943, using specified electrical equipment and pieces of equipment per 100 farms, by 1947 income groups, April 1948 ¹

Item	Farms reporting equipment			Equipment per 100 farms with		
	Low income	Medium income	High income	Low income	Medium income	High income
Farms represented	Number 87	Number 149	Number 78	Number	Number	Number
Household appliances:	Percent	Percent	Percent	Percent	Percent	Percent
Refrigerator	75.9	86.6	94.9	75.9	89.9	112.8
Range	19.5	38.9	35.9	20.7	39.6	39.7
Water heater	25.3	29.5	41.0	26.4	29.5	47.4
Freezer cabinet	5.7	11.4	14.1	5.7	11.4	17.9
Washing machine	86.2	91.3	96.2	86.2	96.6	125.6
Radio	97.7	98.0	100.0	114.9	149.7	223.1
Iron	96.6	98.0	100.0	98.8	104.0	134.6
Clock	56.3	75.8	82.1	72.4	108.1	139.7
Toaster	74.7	79.9	83.3	74.7	83.2	102.6
Vacuum cleaner	64.4	73.8	91.0	65.5	76.5	111.5
Household fan	42.5	59.7	62.8	49.4	73.2	98.7
Food mixer	25.3	46.3	64.1	25.3	46.3	69.2
Heat pad	26.4	38.9	52.6	27.6	40.9	61.5
Hot plate	35.6	37.6	48.7	35.6	39.6	52.6
Waffle iron	25.3	44.3	60.3	25.3	45.0	69.2
Space heater	9.2	28.2	38.5	9.2	28.9	42.3
Sewing machine	8.0	18.8	21.8	8.0	18.8	21.8
Percolator	9.2	10.7	17.9	9.2	10.7	21.8
Roaster	6.9	4.0	14.1	6.9	4.0	14.1
Ironer		4.0	15.4		4.0	16.7
Coal stoker	4.6	4.7	19.2	4.6	4.7	19.2
Oil furnace	8.0	7.4	7.7	8.0	7.4	9.0
Hot-air fan	12.6	18.1	25.6	12.6	18.1	26.9
Hot-water pump	2.3	3.4		2.3	3.4	
Air-conditioning unit		1.3	1.3		1.3	1.3
Blanket		2.7	3.8		3.4	5.1
Broiler	1.1	2.7	3.8	1.1	2.7	3.8
Ventilating fan		2.7	1.3		2.7	1.3
Ice-cream freezer		2.0	2.6		2.0	2.6
Water systems:						
Pressure system	48.3	60.4	64.1	51.7	75.2	89.7
Gravity system	3.4	13.4	21.8	3.4	13.4	26.9
Pump jack	33.3	34.9	38.5	34.5	37.6	42.3
Farm shop equipment:						
Air compressor	3.4	14.1	35.9	3.4	14.1	35.9
Drill press	6.9	16.8	33.3	8.0	16.8	33.3
Portable drill	1.1	8.7	23.1	1.1	9.4	23.1
Tool grinder	20.7	43.6	62.8	21.8	44.3	70.5
Power saw	8.0	13.4	17.9	9.2	14.1	21.8
Welder	3.4	8.1	24.4	3.4	8.7	24.4
Battery charger	3.4	8.1	7.7	3.4	8.7	7.7
Lathe	2.3	4.0	3.8	2.3	4.0	3.8
Forge	1.1	.7	2.6	1.1	.7	2.6
Concrete mixer	1.1	3.4	6.4	1.1	3.4	6.4
Soldering iron	18.4	28.2	37.2	19.5	29.5	43.6
Dairy equipment:						
Cream separator	33.3	69.1	69.2	33.3	69.8	69.2
Milking machine	9.2	27.5	28.2	9.2	28.2	29.5
Water heater	1.1	6.7	6.4	1.1	6.7	6.4
Ventilator fan		2.0	5.1		2.0	6.4
Churn	1.1	2.0	3.8	1.1	2.0	3.8
Milk cooler		.7	1.3		.7	1.3
Livestock equipment:						
Pig brooder	4.6	10.7	23.1	24.1	36.9	200.0
Tank heater	3.4	14.1	21.8	3.4	15.4	37.2
Fence controller	6.9	12.1	9.0	6.9	12.8	11.5
Stock clipper		1.3	3.8		1.3	3.8
Poultry equipment:						
Brooder hover	26.4	51.0	41.0	27.6	55.0	47.4
Brooder-battery		.7	1.3		.7	1.3
Water warmer	6.9	21.5	28.2	10.3	29.5	43.6

TABLE 15.—Percentage of farms electrified before Jan. 1, 1943, using specified electrical equipment and pieces of equipment per 100 farms, by 1947 income groups, April 1948 ¹—Continued

Item	Farms reporting equipment			Equipment per 100 farms with		
	Low income	Medium income	High income	Low income	Medium income	High income
Other farm equipment:	<i>Percent</i>	<i>Percent</i>	<i>Percent</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>
Grain elevator.....	5.7	12.1	20.5	5.7	12.1	23.1
Corn sheller.....	9.2	7.4	7.7	9.2	7.4	7.7
Seed cleaner.....	3.4	6.7	16.7	3.4	6.7	16.7
Feed grinder.....	2.3	.7	1.3	2.3	.7	1.3
Grain drier.....	.....	.7	.....	.....	.7	.....
Hay hoist.....	.....	.7	.....	.....	.7	.....

¹ See footnote 1, table 6.

USE OF HOME FREEZERS AND COLD-STORAGE LOCKERS

Of the older electrified farms, fourth-fifths either had a home freezer cabinet or rented a frozen-food locker at a commercial establishment, or both. Almost 70 percent had rented lockers only, 6 percent had a home freezer only, and 4 percent had both.

Only 6 percent of the high-income farms that had been electrified for 5 years or more had neither a home freezer nor a rented locker. Of the medium-income farms, 13 percent had neither, and 46 percent of the low-income farms had neither. The actual numbers of farms in each category are indicated in table 16.

More than 85 percent of the commercial farms either had a home freezer or rented a locker but only a third of the noncommercial farms had either.¹⁶ However, 95 percent of the commercial farms with high incomes had at least one home freezer or rented a locker but this was true of only 77 percent of the commercial farms with low incomes.

Distances from the farms to the frozen-food lockers ranged up to 21 miles; the average distance was a little more than 5 miles.

The home freezer is a relatively new development in this area. Only one was reported as having been installed before 1945.

TABLE 16.—Farms electrified before Jan. 1, 1943, using rented frozen-food lockers and home freezers, by 1947 income groups, April 1948

Item	Income group ¹			All farms
	Low	Medium	High	
	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>
Farms with—				
Rented lockers only.....	42	113	62	217
Home freezers only.....	3	12	5	20
Both rented lockers and home freezers.....	2	5	6	13
Neither rented lockers nor home freezers.....	40	19	5	64
Farms represented.....	87	149	78	314

¹ See footnote 1, table 6.¹⁶ See p. 54 for definitions of commercial and noncommercial farms as here used.

WATER SYSTEMS AND PUMPING EQUIPMENT

In this area, running water in the house is no longer considered a luxury available to only a few farmers. Electric power has permitted many farms to have individual water systems. Some farms had water systems, frequently of the gravity type, before they had electricity, but many did not have this convenience until afterward.

More than half of all the farms studied had water systems in 1948. Those that had been recently electrified had not gone as far in this respect as those that had had electricity for some time. About 30 percent of the latter had water systems using electric motors compared with around 65 percent of the older electrified farms (table 7). Tables 17, 18, and 19 contain data on water systems and pumping equipment, and buildings piped for water, that were found on the older electrified farms.

It was not unusual at the time of the survey here discussed for a farm to have two water systems, one for hard water and one for soft, or one for use in the dwelling and one for the service buildings. Two-thirds of the older electrified farms had running water in the dwelling or in the service buildings. Of those with running water, 20 percent had two or more independent systems.

Water was piped to the house only on more than half of the 212 older electrified farms that had running water. Six farms (3 percent) had running water in the service buildings but not in the dwellings. More than 40 percent of these 212 farms had running water in the dwelling and in one or more of the service buildings (table 17).

TABLE 17.—Number and percentage of farms electrified before Jan. 1, 1943, with and without running water and farms which have running water in specified buildings by 1947 income groups, April 1948

Item	Income group ¹						All farms	
	Low		Medium		High			
	Farms	Per-centage	Farms	Per-centage	Farms	Per-centage	Farms	Per-centage
	Num-ber	Per-cent	Num-ber	Per-cent	Num-ber	Per-cent	Num-ber	Per-cent
Farms:								
Without running water.....	43	49	44	30	15	19	102	32
With running water.....	44	51	105	70	63	81	212	68
Total.....	87	100	149	100	78	100	314	100
With running water in:								
Dwellings only.....	34	77	51	48	35	56	120	57
Service buildings only.....	0	0	6	6	0	0	6	3
Dwellings and service buildings.....	10	23	48	46	28	44	86	40
Total.....	44	100	105	100	63	100	212	100

¹ See footnote 1, table 6.

About half of the electrified farms with low incomes had no running water in one building or more; 30 percent of the farms with medium incomes and 20 percent of those with high incomes had no running water in their buildings.

Service buildings more frequently piped for water were general barns, hog houses, and poultry houses (table 18). But even on the electrified farms many of these buildings did not have running water. For example, only 21 percent of the 576 barns, hog houses, and poultry houses on the older farms with water systems were piped for water. A relatively large percentage of the service buildings that were not piped for water were on the low-income farms.

Most of the older electrified farms that had water systems used pressure; some had both pressure and gravity systems (table 19). Most of these systems, 96 percent, were operated with electric equipment; most of the other 4 percent were gravity systems using windmills to lift the water.

Electricity was used to pump water on 35 percent of the older electrified farms. This pumping is separate from the water systems; most of it was done to provide water for livestock, but some was for household use. More electric-powered pump jacks than windmills were in use on these farms (table 19).

In this area windmills are gradually being replaced by electric motors. Some time after a farm is electrified, several days of almost windless weather may come when the windmill will not pump enough water for the livestock. The farmer can ill afford to do the pumping by hand, for he knows that an electric motor using about 5 cents worth of electricity can pump as much water as he can in 8 hours of hard work. So he buys an electric motor and pump jack expecting to use them only occasionally. For several months he uses the windmill at times and the electric motor at other times. Gradually he depends more and more on the electric motor and less and less on the windmill. After a while the windmill needs some major repair; it is taken down and the electric motor is left to do the job alone.

Frequently, the well for stock water is located so far from the farmstead that it is expensive to convert the pump to electricity and then pipe the water to the dwelling and barns. For this reason, a farmer sometimes digs a new well in his service area.

Another deterrent to the installation of water systems was the structure of many farm dwellings. It would have been difficult to keep the water pipes in them from freezing in severe weather. Several farmers said they would not install water systems in the old dwellings but would install them in new ones planned for early construction.

Installing water systems is relatively expensive. Farmers with lower incomes, and some others who have recently electrified their farms, may not feel able to install a water system immediately.

TABLE 18.—Number of buildings with and without running water on farms electrified before January 1, 1943, by 1947 income groups, April 1948¹

Item	Buildings on farms with —						All farms	
	Low incomes		Medium incomes		High incomes		Buildings with running water	Buildings without running water
	Number	Number	Number	Number	Number	Number		Number
Farms—								
With water systems:								
Dwellings-----	44	0	103	13	76	14	223	27
General barns-----	6	32	29	71	18	51	53	154
Hog houses-----	2	27	22	69	13	42	37	138
Poultry houses-----	2	30	18	79	12	53	32	162
Other buildings-----	3	41	18	140	11	106	32	287
Without water systems:								
Dwellings-----		43		46		19		108
General barns-----		38		42		16		96
Hog houses-----		23		44		15		82
Poultry houses-----		35		45		16		96
Other buildings-----		34		62		22		118
Total-----	57	303	190	611	130	354	377	1,268

¹ Low-income included 87 farms with less than \$6,000 total income in 1947; medium-income included 149 farms with from \$6,000 to \$14,999 total income; and high-income included 78 farms with \$15,000 or more total income, a total of 314 farms.

TABLE 19.—*Water systems and miscellaneous water pumping equipment on farms electrified before Jan. 1, 1943, by 1947 income groups, April 1948*

Item	Income group ¹						All farms	
	Low		Medium		High		Electric equipment	Nonelectric equipment
	Electric equipment	Nonelectric equipment	Electric equipment	Nonelectric equipment	Electric equipment	Nonelectric equipment		
	Number	Number	Number	Number	Number	Number	Number	Number
Farms with—								
Water systems:								
Pressure	42	0	90	1	50	1	182	2
Gravity	3	2	20	15	17	6	40	23
Total ²	44	2	100	16	60	7	204	25
Pump jacks—								
Windmills	29	3	53	1	29	1	111	5
Hand pumps		18		49		27		94
Other pumps		10		13		7		30
No pumping equipment		1		1		2		4
Equipment on farms:		7		2				9
Water systems:								
Pressure	45	0	112	1	70	1	227	2
Gravity	3	2	20	15	21	7	44	24
Total	48	2	132	16	91	8	271	26
Miscellaneous:								
Pumping equipment:								
Pump jacks	30	3	56	1	33	1	119	5
Windmills		18		49		38		105
Hand pumps		14		13		9		36
Other pumps ³		1		1		3		5

¹ See footnote 1, table 18.² The total of farms having water systems is less than the total number with pressure and gravity systems because of duplicate systems. The farms having both pressure and gravity system are: Low-income 1, medium-income 10, and high-income 7.³ Includes rotary, centrifugal, and jet pumps.

COMPETING KINDS OF POWER

Liquefied petroleum gases, coal, and kerosene were the principal sources of power that competed with electricity in these farm homes. There was little or no competition in the operation of some appliances. Freezers and air-conditioning units were especially well adapted to electric power. Most furnaces burned coal and wood. Between these extremes, competition among the sources of power was especially keen in the operation of kitchen ranges and water heaters. For these purposes, farmers were turning more and more to electricity.

Evidently there had been no noteworthy shift from gas to electric ranges after the farms were electrified but there had been a substantial shift from coal and kerosene to electric ranges. More than 40 percent of the farms in both the newly electrified and the older electrified groups had gas ranges. Fifteen percent of the newly electrified farms and 33 percent of the older had electric ranges. Coal- and oil-burning ranges were reported on 50 percent of the newly electrified farms and on 35 percent of the older (table 20).

Of the newly electrified farms with low incomes, more than half had kitchen ranges that used neither gas nor electricity, 36 percent had gas ranges, and 11 percent had electric ranges. Half of the high-income farms that were newly electrified had gas ranges and 19 percent had electric ranges; the remainder used other fuel.

Relatively more of the high-income farms had either an electric or a gas range. Almost half of the low-income farms that had been electrified for 5 years or more had ranges that burned coal, wood, or kerosene; only one-fourth of the farms with large incomes had such ranges. Twenty percent of the low-income farms had electric ranges; 36 percent of the high-income farms had at least one, and some had two. Gas ranges were used on 38 percent of the small farms that had been electrified for 5 or more years and on more than half of the older high-income farms.

Electric roasters and hot plates were used on some farms to supplement coal, wood, and kerosene stoves. These appliances were most frequent on the high-income farms. Almost half of the high-income farms had hot plates, compared with 36 percent of the low-income farms. Roasters were found on 14 percent of the farms that had large incomes and on 7 percent of the farms with small incomes.

That comparatively few of the farms with low incomes used electricity for cooking may be partially accounted for by two elements of cost. Electric ranges are relatively expensive and large amounts of energy are required for cooking; electricity is more expensive in this area than are some other sources of heat. An electric range is estimated to use about 100 kilowatt-hours per month, on the average. At 3 cents per kilowatt-hour, the cost of this energy would be \$3 a month. Families who must carefully consider all items of cost find that this means a rather large bill for fuel. Some suppliers make special electric rates for ranges and water heaters to encourage their use.

Nearly all of the refrigerators in use were electric. A few gas refrigerators and ice boxes were reported, especially on the newly electrified farms. Electric refrigerators were used on 86 percent of the older electrified farms and on 69 percent of those newly electrified. There remained a substantial number of farms with no refrigerators of any

TABLE 20.—Percentage of farms electrified before and after Jan. 1, 1943, having specified equipment and pieces of equipment per 100 farms by 1947 income groups, April 1948

Electrified before Jan. 1, 1943 ¹

Item	Farms reporting equipment?				Equipment per 100 farms			
	Low income	Medium income	High income	All farms	Low income	Medium income	High income	All farms
	Percent	Percent	Percent	Percent	Number	Number	Number	Number
Range:								
Electric.....	19.5	38.9	35.9	32.8	20.7	39.6	39.7	34.4
Gas.....	37.9	38.3	56.4	42.7	37.9	38.9	65.4	45.2
Other.....	47.1	32.2	26.9	35.0	48.3	33.6	26.9	36.0
Refrigerator:								
Electric.....	75.9	86.6	94.9	85.7	75.9	89.9	112.8	91.7
Gas.....	1.1	3.4	5.1	1.6	1.1	1.7	5.1	1.6
Other.....	23.0	10.0	2.6	2.5	1.1	3.4	2.6	2.5
None.....				11.1				
Water heater:								
Electric.....	25.3	29.5	41.0	31.2	26.4	29.5	47.4	33.1
Gas.....	4.6	2.7	12.8	5.7	4.6	2.7	12.8	5.7
Other.....	14.9	10.7	11.6	12.1	14.9	10.7	11.6	12.1
None.....	55.2	57.1	34.6	51.0				
Electrified after Jan. 1, 1943 ²								
Range:								
Electric.....	11.3	16.7	18.8	15.0	11.3	16.7	18.8	15.0
Gas.....	35.9	43.6	50.0	41.5	35.9	44.9	50.0	42.2
Other.....	54.7	50.0	37.5	50.3	54.7	50.0	37.5	50.3
Refrigerator:								
Electric.....	58.5	70.5	93.8	68.7	60.4	71.8	100.0	70.7
Gas.....	1.9	2.6	1.4	1.4	2.6	2.6	1.4	1.4
Other.....	39.6	9.0	5.4	5.4	1.9	9.0	5.4	5.4
None.....		17.9	6.2	24.5				
Water heater:								
Electric.....	3.8	6.4	12.5	6.1	3.8	6.4	12.5	6.1
Gas.....	1.9	2.6	2.7	2.7	1.9	2.6	2.7	2.7
Other.....	13.2	11.5	18.8	12.9	13.2	11.5	18.8	12.9
None.....	81.1	80.8	62.5	79.0				

¹ See footnote 1, table 18.

² Some farms had two kinds of some appliances, so the percentage may total more than 100.

³ See table 14 for farms represented in each group.

kind: 11 percent of the older electrified farms and 25 percent of those newly electrified (table 20).

Of the old electrified farms all of those with large incomes had some kind of refrigerator while almost a fourth of the small-income farms had no refrigerator. Of the newly electrified farms, 6 percent of those with large incomes had no refrigerators and 40 percent with small incomes had none.

The cost of the energy used by a home electric refrigerator probably amounted to \$1 to \$1.50 a month. If cost is a deterring factor it would seem likely that the cost of the refrigerator itself—the initial cost, repairs, and depreciation—is the most significant part. A substantial refrigerator that could be sold for considerably less than many of those now on the market might find a place in this area as well as in others.

Electric water heaters are coming in gradually. Six percent of the newly electrified farms had them and 31 percent of the older electrified places had one or more. Gas water heaters were in use on 3 percent of the newly electrified farms and 6 percent of the older. Other kinds of heaters—coal, oil, and kerosene—were used on about 13 percent of the farms in both age groups. Almost four-fifths of the newly electrified farms and half of the others had no heater for use in connection with a water system. Water heaters were much more prevalent among the high-income farms.

Evidently, electric service from power lines facilitated the installation of water systems in the farm homes, and this led to the use of equipment for heating the water automatically and in the volume required. So gas and electric water heaters were installed, the kind depending, among other factors, upon the family's preference.

USES OF ELECTRICITY IN HOME AND ON FARM

Specific kinds of appliances used in farm homes and in or near farm service buildings were itemized. These listings and the estimated consumption of electric energy for each use reported indicate the amount of electric energy that was used for household operations and the amount used for farm operations.

Practically throughout the area all the energy used on a farm was recorded by one meter. An occasional farm had two or more meters—one at one farmstead and one at another, or one for general farm use and one for a specific use, as heating water. As the meters registered all of the energy used, the amounts used for the household and for the farm operation can be reconstructed only by estimating the energy required for the specific applications reported. Estimates for this purpose were provided by the Agricultural Engineering Department of the Iowa Agricultural Experiment Station and by the Rural Electrification Administration of the United States Department of Agriculture. These estimates must have been reasonably accurate because the estimated total consumption of the 461 farms in the sample area as reconstructed from them was only 5 percent above the actual total amount reported by the suppliers. For some individual farms, estimates were inaccurate but on the average they were satisfactory.

On the basis of these estimates, four-fifths of the total energy used on farms in the area, in 1947, was for household operations and one-fifth was for farm operations. Differences in home and farm consumption

TABLE 21.—Consumption of electric energy per farm by income groups and specified use, 1943
On farms electrified before Jan. 1, 1943

Item	Income group						A farms
	Under \$4,000	\$4,000– 5,999	\$6,000– 9,999	\$10,000– 14,999	\$15,000– 19,999	\$20,000– 24,999	\$25,000 and over
Farms represented	Number 46	Number 41	Number 70	Number 79	Number 29	Number 25	Number 24
Household operations:							
Water systems	Kw.-hrs. 71	Kw.-hrs. 62	Kw.-hrs. 72	Kw.-hrs. 97	Kw.-hrs. 91	Kw.-hrs. 130	Kw.-hrs. 106
Lighting	231	234	279	338	394	392	329
Appliances	902	1,016	1,444	1,773	2,112	2,326	3,078
Total	1,204	1,312	1,795	2,208	2,597	2,848	3,781
Farm operations:							
Water systems	9	8	31	46	54	27	58
Lighting	43	59	81	97	108	106	87
Equipment	55	138	342	495	610	342	829
Total	107	205	454	638	772	475	1,036
Total farm and household	1,311	1,517	2,249	2,846	3,369	3,323	4,817
							2,551
On farms electrified after Jan. 1, 1943							
Farms represented	Number 26	Number 27	Number 53	Number 25	Number 8	Number 4	Number 4
Household operations:							
Water systems	Kw.-hrs. 18	Kw.-hrs. 27	Kw.-hrs. 38	Kw.-hrs. 31	Kw.-hrs. 84	Kw.-hrs. 48	Kw.-hrs. 22
Lighting	308	240	267	296	431	289	328
Appliances	685	576	694	812	1,063	2,003	613
Total	1,011	843	999	1,139	1,578	2,340	963
Farm operations:							
Water systems	2	11	11	28	19	24	44
Lighting	49	59	79	88	104	72	46
Equipment	118	128	265	288	412	220	22
Total	169	198	355	404	535	310	112
Total farm and household	1,180	1,041	1,354	1,543	2,113	2,650	1,075
							1,367

Farms represented	Number 72	Number 68	Number 123	Number 104	Number 37	Number 29	Number 28	Number 461
Household operations:	<i>Kw.-hrs.</i>	<i>Kw.-hrs.</i>	<i>Kw.-hrs.</i>	<i>Kw.-hrs.</i>	<i>Kw.-hrs.</i>	<i>Kw.-hrs.</i>	<i>Kw.-hrs.</i>	<i>Kw.-hrs.</i>
Water systems	56	48	58	81	87	116	94	70
Lighting	251	236	274	330	390	378	578	315
Appliances	833	843	1,119	1,540	1,902	2,287	2,719	1,363
Total	1,140	1,127	1,451	1,951	2,379	2,781	3,391	1,748
Farm operations:								
Water systems	8	9	23	40	47	26	60	26
Lighting	44	59	80	96	105	100	133	83
Equipment	72	133	309	446	567	323	698	317
Total	124	201	412	582	719	449	891	426
Total farm and household	1,264	1,328	1,863	2,533	3,098	3,230	4,282	2,174

between the older and the newer electrified farms was not significant. The older electrified farms used 81 percent for household purposes and the newly electrified farms 78 percent. The average amount of energy used by the older electrified farms for household purposes in 1947 was approximately 2,069 kilowatt-hours and for farm operations, 482 kilowatt-hours (table 21). The newly electrified farms averaged about 1,065 kilowatt-hours for household use and 302 kilowatt-hours for farm use. The averages for all farms were 1,748 and 426 kilowatt-hours for home and farm use respectively.

The small farms—that is, those with low incomes in both the older electrified and the newer electrified age groups—used a smaller proportion of the total for farm operations than did either the medium- or large-income farms. For example, the small-income farms that had been electrified for 5 years or more used about 90 percent of the total consumption for the household while the medium-income farms used about 78 percent of their total in their households, and the large-income farms used approximately 80 percent.

It seems reasonable to expect farms with small incomes to use a larger proportion of their electric energy for household purposes than the farms with larger incomes. Their farm businesses are small. They have few if any cows so have no use for milking machines. They have few chickens so they do not have much need for lights in the poultry house. They have little other livestock so they do not need to pump much water or to have tank heaters. Nine-tenths of the noncommercial farms were small businesses, as measured by the 1947 total income.

The large-income farms—that is, those with incomes of \$15,000 or more in 1947—used a slightly larger percentage of their electric energy for household purposes than did the medium-income farms. A principal reason is that 30 more dwellings per hundred farms were wired on the large farms than on the medium-sized places; hence there was more reason for using home appliances on the large farms and the need for farm equipment did not increase in proportion.

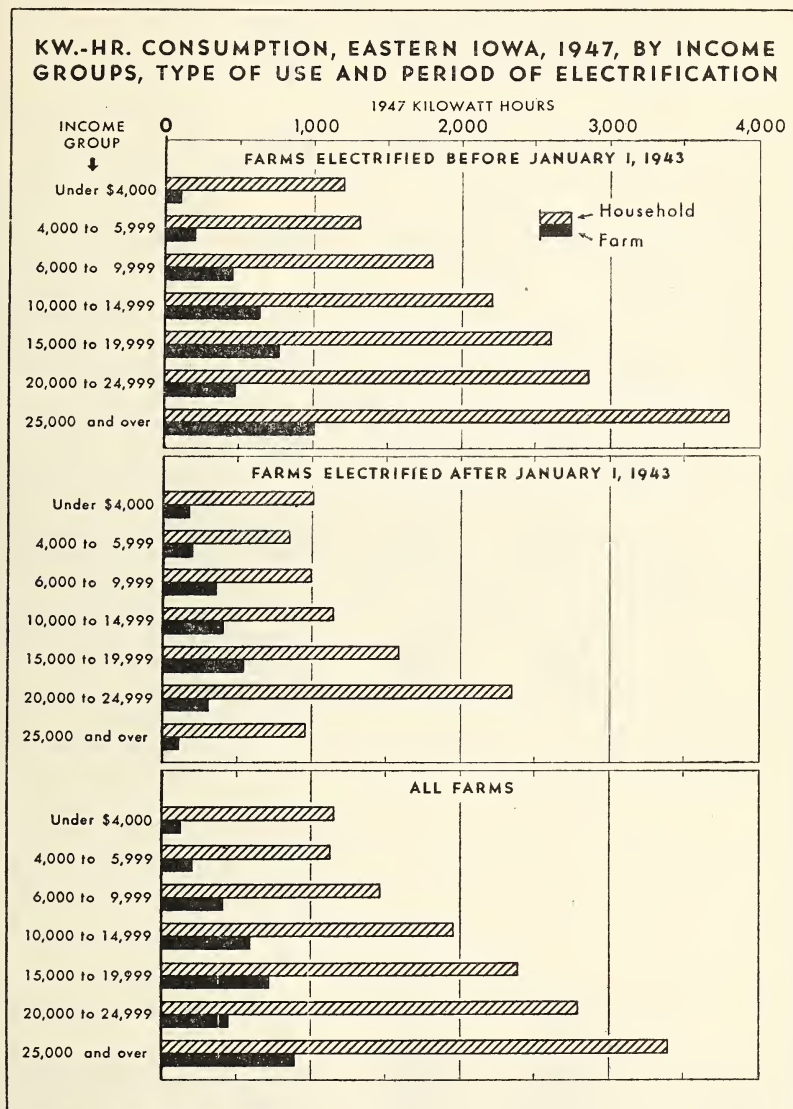
In the older electrified group of farms in 1947 there was a tendency for the use of electricity, both in the home and on the farm, to increase as total incomes became larger. When the farms were grouped on the basis of total incomes, each succeeding income group used more electricity for the household than the previous one (fig. 5). With one exception, the same condition existed with respect to farm use of electricity.

The one exception was in the \$20,000 to \$24,999 income class which apparently used a smaller number of kilowatt-hours for farm operations than did the next smaller income group. This figure probably was due to sampling error rather than to a peculiarity of the farms having these incomes. For example, no farm in this income group had more than nine milk cows, so this group needed relatively little electric dairy equipment. In both the next smaller group and the next larger group a number of dairy herds of more than nine cows used some energy-consuming equipment, especially water heaters and tank heaters.

In the newly electrified group there was less consistency in the tendency to increase the use of electricity as incomes advanced. Nevertheless, the tendency was apparent both for household and for farm purposes. In the two highest income classes, the amount of energy used for farm operations was less than in some smaller income groups.

However, there were only four farms in each of these high-income groups and half of these had been electrified for only a year.

As two-thirds of all farms studied had been electrified for 5 or more years the composite consumption pattern between the home and the farm business, and among the various income groups, followed the pattern of the older electrified farms.



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FIGURE 5.—In general, farms with high incomes used more electricity in 1947, both for household and farm purposes, than did farms with low incomes. Household consumption on the low- and high-income farms, whether recently electrified or not, makes up a very large part of total consumption.

TABLE 22.—Consumption and cost of electric energy per farm, cost per kilowatt-hour, and per \$1,000 of total income by income groups—1947

Item	Unit	On farms electrified before Jan. 1, 1943							All farms
		Income group							
		Under \$4,000	\$4,000-5,999	\$6,000-9,999	\$10,000-14,999	\$15,000-19,999	\$20,000-24,999	\$25,000 and over	
Consumption per farm	Kw.-hrs.	1,311	1,517	2,249	2,846	3,369	3,323	4,817	2,551
Cost of electricity per farm	Dollars	59.41	65.44	78.32	91.48	104.29	100.00	131.31	85.35
Cost of kilowatt-hour	Cents	4.53	4.31	3.48	3.21	3.10	3.01	2.73	3.35
Cost per \$1,000 of total income	Dollars	22.50	12.86	9.96	7.61	6.13	4.64	3.98	7.33
On farms electrified after Jan. 1, 1943									
Consumption per farm	Kw.-hrs.	1,180	1,041	1,354	1,543	2,113	2,650	1,075	1,367
Cost of electricity per farm	Dollars	58.43	57.65	64.92	69.84	71.57	96.44	77.90	64.85
Cost per kilowatt-hour	Cents	4.95	5.54	4.79	4.53	3.39	3.64	7.25	4.74
Cost per \$1,000 of total income	Dollars	21.63	11.54	7.95	6.04	4.09	4.36	2.46	7.44
On all farms									
Consumption per farm	Kw.-hrs.	1,264	1,328	1,863	2,533	3,098	3,230	4,282	2,174
Cost of electricity per farm	Dollars	59.06	62.35	72.55	86.28	97.22	99.51	123.68	78.81
Cost per kilowatt-hour	Cents	4.67	4.70	3.89	3.41	3.14	3.08	2.89	3.63
Cost per \$1,000 of total income	Dollars	22.18	12.34	9.08	7.24	5.68	4.60	3.77	7.36

COST OF ELECTRICITY TO THE FARMER

Cost of electric energy to the farmer does not appear to have been a limiting factor in the use of electricity on the high-income farms, but on the low-income farms it may have had a restricting influence. The cost of the energy used by the older electrified farms, each with a total income of \$25,000 or more, was only 0.4 percent of the total income of those farms. In the \$6,000 to \$9,999 total-income group the cost of the electricity was 1.0 percent of the total income, whereas for farms of less than \$4,000 total income the cost was 2.25 percent of the total income (table 22).

Although the average monthly bill for the electricity was higher in the upper income brackets the cost per kilowatt-hour was lower. For example, the average monthly bill in 1947 for farms of less than \$4,000 total income was \$4.95 and the average cost per kilowatt-hour was 4.5 cents. For farms of \$6,000 to \$9,999 total income, the average bill per month was \$6.53 and the average cost per kilowatt-hour was 3.5 cents. But for farms of more than \$25,000 total income the average monthly bill was \$10.94, and the cost per kilowatt-hour was only 2.7 cents.

The total electric bill for 1947 varied from an average of about \$59 for the low-income group of farms to about \$124 for farms having incomes of \$25,000 or more. Both the old and newly electrified farms with less than \$4,000 income paid between \$59 and \$60 on the average for electric energy, in 1947. But the newly electrified farms having incomes of \$25,000 or more spent only \$78 for electricity in 1947 compared with an average expenditure of \$131 by the older electrified farms with incomes of \$25,000 and over.

The cost per kilowatt-hour declined as the total cost increased, because all the suppliers in the area had rate schedules that provided for lower average costs as the use of electricity increased. Sample rate schedules for three of the distributors are given in table 23.

TABLE 23.—*Sample rate schedules of three representative distributors, May 1947¹*

Distributor	Kilowatt-hours used	Cost per kilowatt-hour
	<i>Number</i>	<i>Cents</i>
A-----	First—50-----	9.0
	Next—50-----	5.0
	Over—100-----	2.5
B-----	First—40-----	8.75
	Next—40-----	4.0
	Next—120-----	2.5
	Over—200-----	2.0
C-----	First—60-----	5.0
	Next—40-----	3.7
	Next—100-----	2.5
	Over—200-----	1.5

¹ Most suppliers had more than one rate schedule. The rates cited are for average farm conditions.

Each of the suppliers had a minimum charge which was assessed each month even if no electricity was used during the month. For example, distributor B (table 23) made a minimum charge of \$3.50 per month. For this, the farmer could use up to 40 kilowatt-hours in the month. If he used 40 kilowatt-hours or less his bill was \$3.50. All amounts in excess of 40 kilowatt-hours in 1 month were charged on the basis of the actual amount of energy used. The charge for the next 40 kilowatt-

hours was 4 cents per kilowatt-hour, for the next 120 kilowatt-hours it was 2½ cents, and for all amounts over 200 kilowatt-hours in 1 month it was 2 cents per kilowatt-hour.

A farmer who used 100 kilowatt-hours on this schedule in 1 month would be charged \$5.60, exclusive of tax, or an average of 5.6 cents per kilowatt-hour. The charge would be computed in this way:

40 kilowatt-hours (minimum).....	\$3.50
40 kilowatt-hours at 4 cents.....	1.60
20 kilowatt-hours at 2.5 cents.....	.50
Total cost for 100 kilowatt-hours.....	5.60

But if he used four times as much electricity the cost would be only a little more than doubled. The charge for 400 kilowatt-hours in 1 month would be \$12.10, or 3.02 cents per kilowatt-hour. This bill would be calculated in this way:

40 kilowatt-hours (minimum).....	\$3.50
40 kilowatt-hours at 4 cents.....	1.60
120 kilowatt-hours at 2.5 cents.....	3.00
200 kilowatt-hours at 2 cents.....	4.00
Total cost for 400 kilowatt-hours.....	12.10

Some suppliers made special rates for appliances that require large amounts of power, such as water heaters, kitchen ranges, and large motors. Others made special rates for off-peak heating, which means for heating water late at night when the power load on the system is comparatively small.

In estimating the cost of the electricity that would be used by adding one more piece of equipment, incremental cost is more useful than average cost. To make an estimate of incremental cost, three things need to be known. These are (1) the rate schedule used in billing the farm, (2) the average amount of electricity already being used by the farm, and (3) the estimated amount of electricity required per month to operate the equipment.

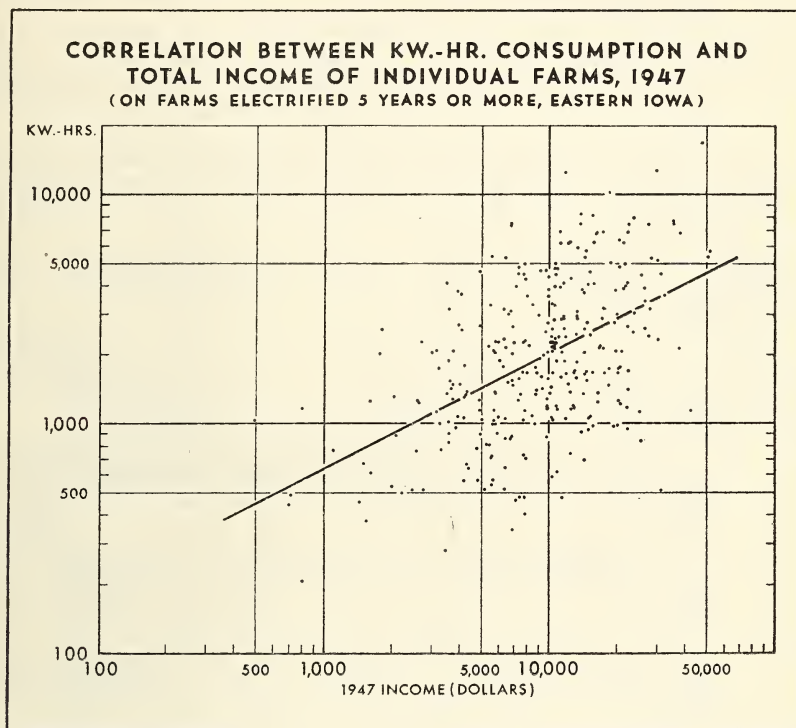
By way of illustration, suppose (1) that a farm is served by Distributor B (table 23), (2) that 100 kilowatt-hours per month are used for lights and other purposes, and (3) that it is necessary to estimate the added cost of the electricity required to operate a piece of equipment that would use about 100 kilowatt-hours a month. Examination of the rate schedule reveals that the second 100 kilowatt-hours would fall entirely within the 2.5 cent bracket. The cost of the 100 kilowatt-hours then would be 100 x 2.5 cents, or \$2.50. But if the farm was already using 200 kilowatt-hours a month, and then installed this same piece of equipment, the added cost would be \$2, since all of this energy would be charged for in the lowest bracket provided by the supplier.

VARIATION IN ELECTRIC CONSUMPTION AMONG INDIVIDUAL FARMERS

That the tendency is for farms with high incomes to use more electricity than those with low incomes does not mean that all farms in any income group used approximately the same amount of electric energy at the time of the survey. On the contrary, in any income group there was a wide variation in the amounts used by individual farmers (fig. 6). For example, in the income group of \$25,000 and over of the older electrified farms the range in actual consumption in 1947 was from 500

to more than 16,000 kilowatt-hours. At the same time, the range in the \$7,500–\$9,999 income group was from a little more than 400 to almost 5,000 kilowatt-hours, and in the group having less than \$2,500 income it was from 200 to 2,600 kilowatt-hours.

No low-income farm was found among the heavy users of electricity and in the higher income brackets the range in individual consumption of electricity was very wide—from less than 1,000 kilowatt-hours to more than 8,000 kilowatt-hours (table 24).



BAE 47572-X

FIGURE 6.—Although farms with high incomes used more electricity in general than did those with low incomes, it is evident that the range in individual farm use at all income levels was wide.

Data obtained in the survey do not clearly disclose the exact reasons why some farms in an income group used 8 or 10 times as much electricity as others. Within the income group of \$15,000 and over, apparently little physical difference could account for the difference in consumption between the farms that were heavy users and those that were small users (table 25). Both groups were larger than average size; both had about the same crops, raised about the same number of spring pigs, had similar dairy herds, and were similar with respect to tenure of operator. The high-consuming farms in this income group, however, used a wide variety of electrical equipment whereas the low-consuming farms followed the more traditional methods of home and farm operation. Three household appliances—kitchen range, refrig-

TABLE 24—Number of farms electrified before and after Jan. 1, 1943, by electricity consumed, and income groups, 1947

Income group	Electrified before Jan. 1, 1943										Total farms
	Farms using indicated kilowatt-hours										
	Under 1,000	1,000-1,999	2,000-2,999	3,000-3,999	4,000-4,999	5,000-5,999	6,000-6,999	7,000-7,999	8,000 and over		
	Number	Number	Number	Number	Number	Number	Number	Number	Number	Number	Number
Under \$2,500	12	4	2	3	2	2					18
\$2,500 to \$4,999	14	21	7	4	4	2					47
\$5,000 to 7,499	18	14	11	4	2	2					53
\$7,500 to 9,999	6	16	7	7	6	3					39
\$10,000 to 14,999	6	25	24	7	7	3	4	1	2		79
\$15,000 to 19,999	2	8	7	3	3	3	4	2	2		29
\$20,000 to 24,999	2	8	4	3	3	2	3	3	2		25
\$25,000 and over	2	2	4	4	2	1	1	3	2		24
Total	62	98	66	28	25	9	12	8	6		314
Electrified after Jan. 1, 1943											
	Number	Number	Number	Number	Number	Number	Number	Number	Number	Number	Number
Under \$2,500	7	1		1							8
\$2,500 to \$4,999	13	11	2	1	2	1					28
\$5,000 to 7,499	25	7			2						35
\$7,500 to 9,999	14	15	3	1	2						35
\$10,000 to 14,999	9	9	6	1							25
\$15,000 to 19,999	1	6						1			8
\$20,000 to 24,999		1	2		1						4
\$25,000 and over	2	2									4
Total	71	52	13	4	5	1		1			147
All electrified farms											
	Number	Number	Number	Number	Number	Number	Number	Number	Number	Number	Number
Under \$2,500	19	5	2	4	2	1					26
\$2,500 to \$4,999	27	32	9	5	4	2					75
\$5,000 to 7,499	43	21	11	5	8	2		2			88
\$7,500 to 9,999	20	31	10	5	7	3	4	1	2		74
\$10,000 to 14,999	15	34	30	8	7	3	4	1	2		104
\$15,000 to 19,999	3	14	7	3	3	3	4	2	2		37
\$20,000 to 24,999	2	9	6	3	4		3	3	2		29
\$25,000 and over	4	4	4	4	2	4	1	3	2		28
Total	133	150	79	32	30	10	12	9	6		461

erator, and water heater—may be used to illustrate some of the differences.

The 10 farms having a high consumption of electric energy, in the \$15,000 and over total-income group, had 16 kitchen ranges; 11 of these were electric and 5 were gas. The 10 farms having a low consumption of electric energy in this group had 13 ranges, none of which were electric; 6 were gas ranges and 7 were other kinds, presumably coal and wood. The 10 high-consuming farms used 15 electric refrigerators and 11 electric water heaters, to the exclusion of all other kinds. The 10 low-consuming farms had 8 electric refrigerators, 1 that burned gas, and 2 others which were presumably ice boxes. These low-consuming farms had 1 electric water heater (installed in 1947), 3 that burned coal or wood, and 1 that burned gas (table 25).

TABLE 25.—*Selected characteristics and equipment on specified high-income farms electrified before Jan. 1, 1943, having the highest and lowest annual consumption of electricity, 1947*¹

Characteristics of farms and equipment used	Unit	10 farms using largest amounts of electricity	10 farms using smallest amounts of electricity
Characteristics:			
Per farm:			
Electricity consumed.....	Kw.-hrs.....	9,193	958
Total income.....	Dollars.....	27,330	23,175
Acreage operated.....	Acres.....	379	286
Spring pigs raised.....	Number.....	158	144
Livestock kept.....	Animal units.....	97	89
Average time electrified.....	Years.....	12.6	9.7
Farms with dairy herds of 10 or more cows.....	Number.....	2	2
Tenant operators.....	Percent.....	30	30
Equipment:			
Ranges:			
Electric.....	Number.....	11	6
Gas.....	do.....	5	7
Other.....	do.....		
Refrigerators:			
Electric.....	do.....	15	8
Gas.....	do.....		1
Other.....	do.....		2
Water heaters:			
Electric.....	do.....	11	1
Gas.....	do.....		1
Other.....	do.....		3
Milking machines:			
Electric.....	do.....	4	1
Chick brooders:			
Electric.....	do.....	8	3
Pig brooders:			
Electric.....	do.....	95	1

¹ Farms having income of \$15,000 or more.

The high-consuming farms had more equipment for use in the farming operations than did the low-consuming farms. They had more shop equipment, more milking machines, more stock-tank heaters, and more barn ventilator fans and brooders for pigs and chicks. But these differences were not so marked as the differences in the number and variety of household appliances.

When related to the uses made of electricity on these farms, the actual number of kilowatt-hours used indicates that the low-consuming farms were frugal with the use of the equipment they owned. Evidently they were careful with their lights and equipment, whereas the high-consuming farms used them more freely.

In this high-income class, therefore, the difference between farms that used a great deal of electricity and those that used less is apparently due chiefly to the personal preferences of the operator and his family. These personal choices were found in the lower income groups as well, but the range of choice was more restricted.

USE OF ELECTRICITY ON FARMS OF DIFFERENT TYPES

One of the purposes of this study was to learn the relationships that exist between the different types of farms that are common in this area and the uses made of electricity.

Records were taken from all the occupied tracts of land—outside of towns and cities—when the farm headquarters was located within a sampling segment. There was one exception to this rule; a record was not taken if the residence was used in connection with a store, a filling station, or any other commercial enterprise. After the records were obtained each tract was put in its proper place in the type-of-farming category, on the basis of the sources of the 1947 income.

As used in this report, noncommercial farms consist of (1) tracts of less than 3 acres from which less than \$250 worth of agricultural product was obtained in 1947; (2) tracts of less than 3 acres from which 250 or more dollars worth of product was obtained, more than half of which was used in the household; and (3) tracts of more than 3 acres from which more than half of the value of the commodities produced were consumed in the household. There were 46 of these noncommercial farms in the sample. Commercial farms are all tracts of more than 3 acres, and tracts of less than 3 acres that produced \$250 worth of product or more in 1947, from which tracts (in both cases) the value of products sold exceeded the value of the products used in the household. The commercial farms were further classified into hog, beef-hog, cash-crop, and general farms.

Of the 461 farms surveyed, more than half, or 242 farms, were classified as hog farms. These were farms for which the value of hogs sold exceeded half of the total value of all products sold. Beef-hog farms were those for which the sales of cattle, or cattle and hogs, or cattle and hogs and sheep, exceeded half of the total value of all products sold. Forty-seven tracts were classified as beef-hog farms.

Records were obtained from 59 cash-crop farms, or those for which the value of crops sold exceeded half of the total value of all products sold. The remaining 67 farms were classified as general farms; this group included 57 general farms, 4 poultry farms, and 6 dairy farms. (The figures quoted for this group are predominantly those of the general farms. There were too few of the poultry and dairy farms to list them separately and they had little effect on the totals or averages of the group.)

The commercial farms were comparatively uniform in their farming operations (table 26). That some were classified as one type and some as another was mainly due to differences in emphasis on certain enterprises rather than to differences in the kind of enterprises. Most of the cash-crop farms sold some livestock, had a flock of chickens, and milked one or more cows. Most of the hog farms sold some crops and some cattle.

The beef-hog farms were the largest of the group; they averaged 235

acres per farm. The general farms were the smallest, with an average of 139 acres. The beef-hog farms had the highest income; the general farms the lowest. Half of the cash-crop farms were tenant-operated but only one-fourth of the beef-hog farms were operated by tenants.

TABLE 26.—*Characteristics of all farms, by type of farm, 1947*

Characteristic	Unit	Type of farm					All farms
		Hog	Beef-hog	Cash-crop	General ¹	Noncommercial ²	
Farms represented	Number	242	47	59	67	46	461
Electricity consumed	Kw.-hrs.	2,261	2,554	2,262	2,151	1,239	2,174
Acreage operated	Acres	177	235	208	139	9	165
Acreage in crops	do	115	144	160	92	2	109
Income:							
Gross farm	Dollars	11,475	15,337	10,545	6,916	351	9,977
Off-farm	do	401	191	409	512	3,756	732
Total income	do	11,876	15,528	10,954	7,428	4,107	10,709
Animal units	Number	49.43	69.69	25.23	30.84	2.41	41.01
Farms:							
Tenure:							
Full owner	do	113	26	19	34	32	224
Part owner	do	38	10	9	5	1	63
Tenant	do	91	11	31	28	13	174
Multiple dwelling:							
Two wired	do	21	9	10	4	1	45
Three wired	do	1			1		2

¹ Includes 57 general farms, 4 poultry farms, and 6 dairy farms.

² Includes 31 farms producing mainly for household use and 15 rural residences.

The noncommercial farms averaged less than 9 acres, with less than 2 acres in crops. About half of the operators of these small tracts were elderly, with few if any young people in the families. Data concerning the age composition of the families were not obtained, but information as to income and land ownership indicates that about a third of these operators were retired farmers who depended mainly on rentals from their land for an income. On an average these operators had lived on the same tracts of land for 27 years. The average period of electrification was 11 years. There were no electric ranges on these farms, and apparently these farmers made comparatively little use of electricity.

Most of the remaining noncommercial farms were operated by part-time farmers who were laborers whose jobs took them away from their farms on most working days. Many lived on tracts of an acre or less, although some tracts were somewhat larger. Usually a cow, a pig or two, and some poultry, were kept. Gardens were usual and occasionally a small patch of corn or other feed crop was found. These places had little need for electrically operated farm equipment other than shop tools.

No significant difference was found among the four types of commercial farms, hog, beef-hog, cash-crop and general, in the average amount of electricity used (table 26). In the older electrified farm group, cash-crop farms used the most electricity, averaging 2,908 kilowatt-hours in 1947 and the "general" farms used the least, or an average of 2,633 kilowatt-hours. This means a difference of only 275 kilowatt-hours for the year.

The real difference in consumption of electric energy was between the commercial and the noncommercial farms. The former used an average of 2,718 kilowatt-hours in the year 1947 and the latter used only 1,260 kilowatt-hours (table 27).

Of all the electricity used in 1947 by the commercial farms that had been electrified for 5 years or more, 80 percent was used for the household. This ranged from 85 percent by the cash-crop farms to 74 percent by the general farms. On the other hand, almost 95 percent of all electricity used by the noncommercial farms was for the household.

Based on estimates of the average consumption of the different appliances, the 278 older electrified commercial farms used 87 kilowatt-hours for pumping water for the household and 34 for pumping water for livestock. They used 341 kilowatt-hours for lighting the dwelling and 95 for lighting the service buildings and service area. The operation of household appliances required 1,749 kilowatt-hours and the operation of the farm equipment 412 kilowatt-hours.

TABLE 27.—Consumption of electric energy per farm electrified before Jan. 1, 1943, by type of farm and specified use—1947

Item	Type of farm					All farms
	Hog	Beef-hog	Cash-crop	General ¹	Noncommercial ²	
Farms represented-----	Number 161	Number 38	Number 39	Number 40	Number 36	Number 314
Household operations:	<i>Kw.-hrs.</i>	<i>Kw.-hrs.</i>	<i>Kw.-hrs.</i>	<i>Kw.-hrs.</i>	<i>Kw.-hrs.</i>	<i>Kw.-hrs.</i>
Water systems-----	83	90	113	76	83	87
Lighting-----	328	340	410	329	219	329
Equipment-----	1,726	1,874	1,946	1,533	885	1,653
Total-----	2,137	2,304	2,469	1,938	1,187	2,069
Farm operations:						
Water systems-----	40	31	17	29	11	30
Lighting-----	94	90	99	97	38	87
Equipment-----	401	388	323	569	24	365
Total-----	535	509	439	695	73	482
Total farm and household-----	2,672	2,813	2,908	2,633	1,260	2,551

¹ Includes 35 general farms, 3 poultry farms, and 2 dairy farms.

² Includes 25 farms producing mainly for household use and 11 rural residences.

The different types of commercial farms were also similar in the amounts of electricity employed for the types of uses. The general farms used somewhat less electricity for household equipment and somewhat more for the operation of equipment used in farming operations than did the other types of farms, but even these differences were not large.

The older electrified farms in each type-of-farm group used more electricity than the newer electrified farms in the corresponding type. The least difference was in the noncommercial farms; the largest was in the cash-crop farms (tables 28 and 29). In some other physical and economic characteristics there were substantial differences for some items, between the older and newly electrified farms. But in the main, each group of commercial farms was large enough and had income enough to permit the use of a great deal of electricity.

ELECTRICAL APPLIANCES AND EQUIPMENT IN USE

On an average, each type of commercial farm had about the same number and variety of electrically operated household appliances as did the other types. But certain differences were found in the kinds of productive equipment used. Hog farms used more pig brooders naturally, but the cash-crop farms used more shop equipment, such as welders, air compressors, and drill presses. The general farms used more milking machines, cream separators, dairy water heaters, chick brooders, and poultry water warmers, than did any of the other types (table 30).

TABLE 28.—*Characteristics of farms electrified before Jan. 1, 1943, by type of farm, 1947*

Characteristic	Unit	Type of farm					All farms
		Hog	Beef-hog	Cash-crop	General ¹	Noncommercial ²	
Farms represented.....	Number.....	161	38	39	40	36	314
Electricity consumed.....	Kw.-hrs.....	2,672	2,813	2,908	2,633	1,260	2,551
Acreage operated.....	Acres.....	185	226	232	136	8	169
Acreage in crops.....	do.....	122	145	180	91	1	114
Income:							
Gross farm.....	Dollars.....	12,593	15,164	11,893	7,489	366	10,765
Off-farm.....	do.....	421	213	607	648	4,140	874
Total income.....	do.....	13,014	15,377	12,500	8,137	4,506	11,639
Animal units.....	Number.....	52.03	65.32	27.98	32.97	2.58	42.55
Farms:							
Tenure:							
Fullowner.....	do.....	78	21	11	23	27	160
Part owner.....	do.....	29	8	8	3	1	49
Tenant.....	do.....	54	9	20	14	8	105
Multiple dwelling:							
Two wired.....	do.....	17	8	9	4	1	39
Three wired.....	do.....	1			1		2

¹ Includes 35 general farms, 3 poultry farms, and 2 dairy farms.

² Includes 25 farms producing mainly for household use and 11 rural residences.

TABLE 29.—*Characteristics of farms electrified after Jan. 1, 1943, by type of farm, 1947*

Characteristic	Unit	Type of farm					All farms
		Hog	Beef-hog	Cash-crop	General ¹	Noncommercial ²	
Farms represented.....	Number.....	81	9	20	27	10	147
Electricity consumed.....	Kw.-hrs.....	1,446	1,462	1,004	1,438	1,169	1,367
Acreage operated.....	Acres.....	162	272	161	142	14	155
Acreage in crops.....	do.....	101	140	121	94	6	98
Income:							
Gross farm.....	Dollars.....	9,254	16,066	7,914	6,066	296	8,294
Off-farm.....	do.....	362	100	22	313	2,375	428
Total income.....	do.....	9,616	16,166	7,936	6,379	2,671	8,722
Animal units.....	Number.....	44.26	88.18	19.90	27.69	1.82	37.70
Farms:							
Tenure:							
Full owner.....	do.....	35	5	8	11	5	64
Part owner.....	do.....	9	2	1	2		14
Tenant.....	do.....	37	2	11	14	5	69
Multiple dwelling:							
Two wired.....	do.....	4	1	1			6

¹ Includes 22 general farms, 1 poultry farm, and 4 dairy farms.

² Includes 6 farms producing mainly for household use and 4 rural residences.

TABLE 30.—*Pieces of electrical equipment per 100 farms in use on farms electrified before Jan. 1, 1943, by type of farm, April 1948*

Item	Type of farm					All farms
	Hog	Beef-hog	Cash-crop	General ¹	Noncommercial ²	
Farms represented	Number 161	Number 38	Number 39	Number 40	Number 36	Number 314
Household appliances:						
Refrigerator	95.0	97.4	89.7	90.0	75.0	91.7
Range	35.4	50.0	28.2	37.5	16.7	34.4
Water heater	32.9	34.2	41.0	35.0	22.2	33.1
Freezer cabinet	12.4	5.3	7.7	20.0	8.3	11.5
Washing machines	105.0	105.3	97.4	97.5	86.1	101.0
Radio	159.0	171.1	176.9	155.0	125.0	158.3
Iron	111.8	115.8	110.3	110.0	97.2	110.2
Clock	112.4	115.8	102.6	110.0	66.7	106.0
Toaster	85.7	89.5	97.4	82.5	72.2	85.7
Vacuum cleaner	87.6	78.9	87.2	62.5	77.8	82.2
Household fan	77.6	86.8	76.9	57.5	50.0	72.9
Food mixer	50.9	47.4	46.2	40.0	30.6	46.2
Heat pad	41.6	60.5	33.3	47.5	30.6	42.4
Hot plate	41.6	50.0	43.6	37.5	36.1	41.7
Waffle iron	46.0	52.6	48.7	47.5	30.6	45.5
Space heater	27.3	44.7	23.1	27.5	8.3	26.8
Sewing machine	19.3	23.7	10.3	15.0	5.6	16.6
Percolator	14.9	7.9	17.9	10.0	8.3	13.1
Roaster	7.5	7.9	10.3	2.5	8.3	7.3
Ironer	8.1	7.9	2.6	2.5	2.8	6.1
Coal stoker	6.2	15.8	17.9		8.3	8.3
Oil furnace	7.5	5.3	12.8	7.5	8.3	8.0
Hot-air fan	18.0	21.1	20.5	20.0	16.7	18.8
Hot-water pump	3.1		2.6	2.5		2.2
Air-conditioning unit	1.9					1.0
Blanket	3.7	2.6		5.0		2.9
Broiler	1.9	2.6	7.7		2.8	2.5
Water systems:						
Pressure	69.6	79.5	92.1	67.5	61.1	72.3
Gravity	18.0	12.8	7.9	15.0	2.8	14.0
Pump jack	40.4	41.0	42.1	40.0	16.7	37.9
Farm shop equipment:						
Air compressor	19.3	13.2	23.1	12.5	5.6	16.6
Drill press	18.6	18.4	30.8	17.5	5.6	18.5
Portable drill	14.9	10.5	7.7	5.0		10.5
Tool grinder	47.2	60.5	56.4	35.0	13.9	44.6
Power saw	14.3	18.4	20.5	7.5	13.9	14.6
Welder	9.3	15.8	23.1	7.5	5.6	11.1
Battery charger	6.8	15.8	7.7	2.5	2.8	7.0
Concrete mixer	1.9	5.3	7.7	2.5	5.6	3.5
Soldering iron	36.6	28.9	30.8	25.0	8.3	30.3
Dairy equipment:						
Cream separator	62.7	65.8	59.0	80.0	16.7	59.6
Milking machine	23.6	28.9	23.1	37.5		23.2
Water heater	6.2	2.6	2.6	10.0		5.1
Ventilator fan	1.9	2.6	7.7	2.5		2.5
Livestock equipment:						
Pig brooder	118.6	21.1	48.7	27.5	8.3	73.9
Tank heater	23.0	15.8	15.4	15.0		17.5
Fence controller	14.3	7.8	7.7	12.5		10.8
Stock clipper	1.2	2.6		2.5	2.8	1.6
Poultry equipment:						
Brooder hover	45.3	63.2	35.9	65.0	16.7	45.5
Brooder—battery	.6	2.6				.6
Water warmer	31.1	26.3	28.2	40.0		27.7
Other farm equipment:						
Grain elevator	14.3	21.1	12.8	7.5	5.6	13.1
Corn sheller	7.5	2.6	5.1	20.0	5.6	8.0
Seed cleaner	10.6	5.3	10.3	5.0	2.8	8.3
Feed grinder	1.2		5.1			1.3
Grain drier		2.6				.3
Hay hoist	.6					.3

¹ Includes 35 general farms, 3 poultry farms, and 2 dairy farms.² Includes 25 farms producing mainly for household use and 11 rural residences.

Although the different types of commercial farms that had been electrified for 5 years or more were rather similar as to the total amount of electric energy used and equipment employed, a decided contrast was noted between the commercial farms as a whole and the non-commercial farms. The noncommercial farms used less than half as much electricity on the average in 1947 as did the commercial farms. They had fewer electric refrigerators, ranges, water heaters, and washing machines per farm. None had an electric milking machine, a dairy water heater, a stock-tank heater, or certain other productive appliances. In fact, the noncommercial farms had a smaller number of practically every appliance or piece of equipment per farm, whether for household or for farm use, than did the commercial farms.

HOME AND FARM LIGHTING

Approximately 16 percent of all the electricity used in 1947 on the commercial farms that had been electrified for 5 years or more was used for lighting. This includes electricity for lighting the dwellings, the service buildings, and the yards. The range among the farm types was from about 15 percent on the beef-hog farms to 18 percent on the cash-crop farms. The noncommercial farms used a little more than 20 percent of their total for lighting.

The commercial farms as a group averaged 7.8 permanent buildings per farm of which 5.8, or 73.8 percent, were wired for electricity. The noncommercial farms had an average of 4.5 permanent buildings per farm, of which 3.3 or 73.4 percent were wired.

The types of commercial farms differed little in the number of wired buildings per farm. Cash-crop farms had a few more wired shops, grain-storage buildings, and corn cribs than did the other types; general farms had a few more dairy barns (table 31). The average number of yard lights was about the same on the different types. The cash-crop and beef-hog farms each averaged 1.3 yard lights per farm, the hog farms 1.2, and the general farms 1.1.

The noncommercial farms had a smaller number of every kind of building listed and a smaller number of yard lights than did the commercial farms. Only limited farming was done on these farms and few buildings were needed.

COST OF ELECTRICITY

The average cost of electric energy used in 1947 by the various types of commercial farms ranged within narrow limits from 3.42 cents per kilowatt-hour for the beef-hog farms to 3.71 cents for the general farms (table 32). The average annual cost ranged from \$79.90 for the general farms to \$87.37 for the beef-hog farms, or from \$6.66 to \$7.28 per month. When compared with the total incomes of these farms, the cost of the electricity used is small—less than three-fourths of 1 percent of the income.

The noncommercial farms used less electricity in 1947 than the commercial farms, with a higher cost per kilowatt-hour. The average monthly bill for the noncommercial farms was \$4.66. The average cost per kilowatt-hour was 4.5 cents. The total cost of the electricity used by these farms was 1.36 percent of their total income.

TABLE 31.—Number of farms and buildings and number and percentage of buildings wired, by type of farm and kind of buildings, April 1918

Item	Hog farms				Beef-hog farms				Cash-crop farms			
	With build-ings ¹	Buildings			With build-ings ¹	Buildings			With build-ings ¹	Buildings		
		Total	Wired			Total	Wired			Total	Wired	
			Number	Percent- age			Number	Percent- age			Number	Percent- age
Dwelling-----	242	267	Number	Percent	47	56	Number	Percent	59	69	Number	Percent
General barn-----	233	240	217	90.4	47	52	44	84.6	54	61	53	86.9
Dairy barn-----	23	24	22	91.7	1	1	0	0	4	4	4	100.0
Beef barn-----	58	58	31	53.4	13	14	8	57.1	10	11	5	45.4
Hog house-----	194	225	139	61.7	35	38	16	42.1	32	35	18	51.4
Poultry house-----	220	230	134	67.0	41	43	27	62.8	51	56	31	55.4
Brooder house-----	179	196	135	68.9	33	38	28	73.7	35	37	26	70.3
Milk house-----	64	65	63	96.9	12	13	11	84.6	14	15	11	73.3
Crib & grain storage-----	200	236	119	50.4	36	41	24	58.5	44	51	34	66.7
Garage-----	181	188	123	65.4	42	42	26	61.9	41	45	27	60.0
Shop-----	125	116	91	78.4	19	22	20	90.9	28	29	28	96.6
Cave-----	26	26	22	84.6	0	0	0	0	5	5	4	80.0
Other buildings ² -----	55	72	44	61.1	13	20	12	60.0	16	17	14	82.4
General farms ³												
Noncommercial farms ⁴												
Dwelling-----	67	74	73	98.6	46	47	47	100.0	461	513	510	99.4
General barn-----	55	57	54	94.7	33	34	25	73.5	422	444	393	88.5
Dairy barn-----	12	12	11	91.7	1	1	0	0	41	42	37	88.1
Beef barn-----	9	9	4	44.4	3	4	0	0	93	96	48	50.0
Hog house-----	54	59	32	54.2	12	12	6	50.0	327	369	211	57.2
Poultry house-----	62	64	48	75.0	29	29	18	62.1	403	422	278	65.9
Brooder house-----	51	54	41	75.9	14	15	11	73.3	312	340	241	70.9
Milk house-----	23	23	22	95.6	3	3	2	66.7	116	119	109	91.6
Crib & grain storage-----	52	57	32	56.1	18	19	11	57.8	350	404	220	54.5
Garage-----	44	45	32	71.1	26	26	17	65.4	346	346	225	65.0
Shop-----	27	28	22	78.6	8	8	8	100.0	197	203	169	83.3
Cave-----	6	6	4	66.7	0	0	0	0	37	37	30	81.1
Other buildings ² -----	10	13	10	76.9	8	9	7	77.8	102	131	87	66.4
All farms												

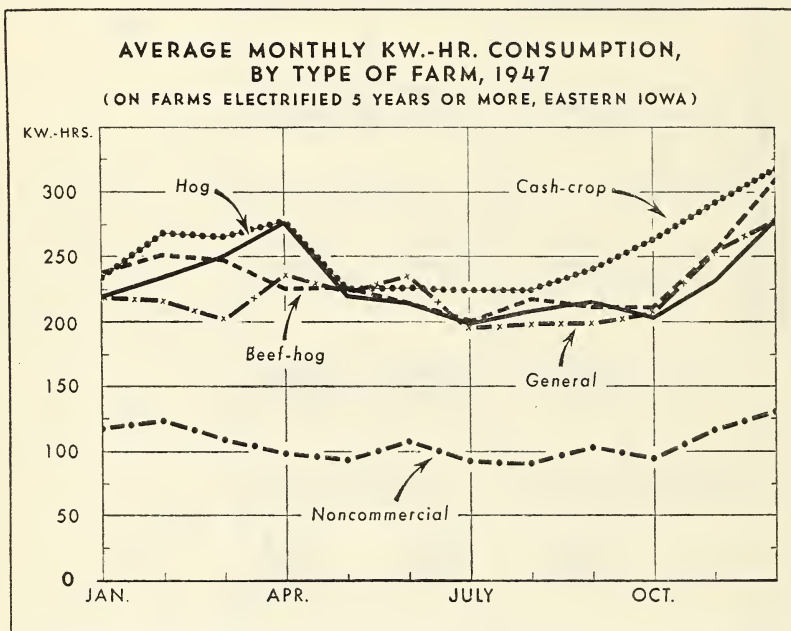
¹ The number of farms represented under each type of farm is the same as the number of farms with dwellings.² Machine sheds, wash houses, tool sheds, etc.³ Includes 57 general farms, 4 poultry farms, and 6 dairy farms.⁴ Includes 31 farms producing mainly for household use and 15 rural residences.

TABLE 32.—Consumption and cost of electric energy per farm, cost per kilowatt-hour and per \$1,000 of total income, by type of farm—1947

Electricity	Unit	On farms electrified before Jan. 1, 1943					All farms
		Type of farm					
		Hog	Beef-hog	Cash-crop	General	Non-commercial	
Consumption per farm	Kw.-hrs.	2,672	2,813	2,908	2,633	1,260	2,551
Total cost per farm	Dollars	87.36	91.07	94.27	89.07	56.55	85.35
Cost per kilowatt-hour	Cents	3.27	3.24	3.24	3.38	4.49	3.35
Cost per \$1,000 of total income	Dollars	6.71	5.92	7.54	10.95	12.55	7.33
On farms electrified after Jan. 1, 1943							
Consumption per farm	Kw.-hrs.	1,446	1,462	1,004	1,438	1,169	1,367
Total cost per farm	Dollars	66.32	71.76	59.40	66.32	53.60	64.85
Cost per kilowatt-hour	Cents	4.59	4.91	5.92	4.61	4.59	4.74
Cost per \$1,000 of total income	Dollars	6.90	4.44	7.48	10.40	20.07	7.44
On all farms							
Consumption per farm	Kw.-hrs.	2,261	2,554	2,262	2,151	1,239	2,174
Total cost per farm	Dollars	80.32	87.37	82.45	79.90	55.91	78.81
Cost per kilowatt-hour	Cents	3.55	3.42	3.64	3.71	4.51	3.63
Cost per \$1,000 of total income	Dollars	6.76	5.63	7.53	10.76	13.61	7.36

SEASONAL CONSUMPTION OF ELECTRICITY

Hog farms that had been electrified for 5 years or more had two peaks of consumption in 1947. The billing sheets indicate that these came in April and December, but because of the time lag between the use of the electricity and the billing, the peaks probably came about a month earlier (fig. 7). The spring peak on these farms probably was due largely to the use of pig brooders, chick brooders, and lights used in connection with the care of young pigs and chicks. The fall or winter peak probably was due to the use of electrical equipment added during the year as well as to the greater use of lights in the long evenings.



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FIGURE 7.—Farms of all types used more electricity in the winter and spring than in the summer, but the commercial farms with their higher incomes and larger livestock enterprises used 84 percent more electricity than did the noncommercial farms.

Cash-crop farms that had been electrified for 5 years or more had the same peaks of consumption, and the causes were probably similar. Most of these farms had hogs and chicks and brooders for both were needed. The spring consumption on the beef-hog and the general farms was more irregular but in both cases there was a pronounced December peak.

The general farms showed the least variation in seasonal use of any of the types of commercial farms. They had more milking machines, cream separators, and dairy water heaters than the others. These appliances are used throughout the year, in contrast to stock tank heaters and pig brooders which are used only a part of the year.

The older electrified noncommercial farms used an average of 122 kilowatt-hours per month in the winter months—November, December, January, and February—and an average of 100 kilowatt-hours in the other months. The peak month for these farms was December, with a 131 kilowatt-hour average; the low was August, with a 91 kilowatt-hour average. In each month of 1947, the average noncommercial farm used about half, or less than half, as much electricity as the average of the commercial farms for that month (table 33).

VARIATIONS IN AVERAGE CONSUMPTION

Although commercial farms that had been electrified before January 1, 1943, consumed an average of 2,718 kilowatt-hours in 1947, 47 percent used less than 2,000, 23 percent used between 2,000 and 2,999, and 5 percent used 7,000 kilowatt-hours or more (table 34).

Half the noncommercial farms that were electrified before January 1, 1943, used less than 1,000 kilowatt-hours and a third used between 1,000 and 1,999 kilowatt-hours in 1947. None used as much as 5,000 kilowatt-hours.

TABLE 33.—Consumption of electric energy per farm electrified before Jan. 1, 1943, by type of farm, and months—1947¹

Month	Type of farm					All farms
	Hog	Beef-hog	Cash-crop	General ¹	Noncommercial ²	
	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>
Farms represented ³ -----	143	38	31	38	35	285
	<i>Kw.-hrs.</i>	<i>Kw.-hrs.</i>	<i>Kw.-hrs.</i>	<i>Kw.-hrs.</i>	<i>Kw.-hrs.</i>	<i>Kw.-hrs.</i>
January-----	220	239	235	219	118	211
February-----	235	253	269	217	124	225
March-----	251	248	266	202	110	229
April-----	277	226	278	237	99	243
May-----	220	227	226	223	94	206
June-----	215	215	227	237	108	206
July-----	199	200	225	195	93	188
August-----	209	218	225	198	91	196
September-----	216	212	241	199	104	202
October-----	204	212	264	207	95	199
November-----	232	256	293	255	117	231
December-----	279	309	318	279	131	269
Total-----	2,757	2,815	3,067	2,668	1,284	2,605
Monthly average-----	230	235	256	222	107	217

¹ Includes 33 general, 3 poultry, and 2 dairy farms.

² Includes 25 farms producing mainly for household use and 10 rural residences.

³ Numbers of farms are not comparable with those shown on annual tables because the consumption of some farms was reported quarterly.

Almost half of the newly electrified commercial farms used less than 1,000 kilowatt-hours in 1947 and more than 80 percent of them used less than 2,000. Only 1 of the 137 newly electrified commercial farms used as much as 5,000 kilowatt-hours that year.

There were 10 newly electrified noncommercial farms in 1947; 8 of these used less than 1,000 kilowatt-hours.

USE OF ELECTRICITY ON FARMS OF DIFFERENT SIZES

In general, the use of electricity increased as the size of the farm (in terms of acres operated) became larger.¹⁷ For example, the older electrified farms of 260 acres and more used $2\frac{1}{4}$ times as much electricity in 1947 as the farms of less than 70 acres. At the same time the newly electrified farms of 260 acres and over used 55 percent more electricity than did those of less than 70 acres. The yearly average for all farms of these two sizes was 3,136 kilowatt-hours for the large farms, and 1,471, or less than half as much, for the small farms (table 35).

Between these extremes there was a strong tendency for the larger farms to use more electricity than the smaller, but there were some exceptions. In the older electrified group of farms, those that had from 180 to 219 acres used 72 kilowatt-hours less in 1947 than did those that had 140 to 179 acres. In the newly electrified group, farms of less than 70 acres used 72 kilowatt-hours more than those of 140 to 179 acres, and 66 kilowatt-hours more than those of 70 to 139 acres.

On the average, the larger farms had larger volumes of business and had higher incomes than did the small farms (table 36). As the larger farms had larger acreages in crops, they usually produced more livestock and so had more need for certain productive equipment. The large farms also had more wired dwellings per farm than did the small ones. Farms of 140 acres or more averaged 1.18 houses per farm while farms of less than 140 acres had 1 house per farm. By having more wired dwellings, the large farms had more need for household equipment and for home lighting. Forty-four percent of the farms of 140 acres or larger were operated by tenants, compared with 29 percent of the farms of less than 140 acres. Most of the small farms were noncommercial places, with low incomes and relatively little need for electric equipment.

Within the size-of-farm groups the amount of energy used by individual farms varied widely. For the older electrified farms of less than 70 acres, for example, the range for individual farms in 1947 was from 206 to 7,440 kilowatt-hours while for those of 260 acres or more the range was from 505 to 16,773 kilowatt-hours.

These variations in consumption of electricity by individual farmers when classified by size of farm are greater than when the farms are classified by income. These conditions lead to the conclusion that the relation between income and the amount of electricity used was closer than the relation between acres operated and the amount of energy used.

The older electrified farms in the size groups generally had more livestock and higher incomes than the newly electrified farms in similar size groups (tables 37 and 38). This study, however, does not show the effect of years of electrification on changes in farm organization, changes which might lead to greater production of livestock and higher income.

¹⁷ A regression equation of 1947 kilowatt-hour consumption on 1947 acres operated for the 314 farms electrified for 5 years or more is $Y_c = 1778 + 4.5695 X$ with a coefficient of correlation $r = .2932$. The calculated kilowatt-hours is indicated by Y_c while X is the acres operated. This may be compared with the equations for kilowatt-hour consumption and total income, footnote 15, page 26.

TABLE 35.—*Number of farms electrified before and after Jan. 1, 1943, by electricity consumed and size of farm, 1947*
 Electrified before Jan. 1, 1943

Size of farm (acres)	Farms using indicated kilowatt-hours										All farms	Average consump- tion per farm
	Under 1,000	1,000- 1,999	2,000- 2,999	3,000- 3,999	4,000- 4,999	5,000- 5,999	6,000- 6,999	7,000- 7,999	8,000 and over			
		Number	Number	Number	Number	Number	Number	Number	Number	Number		
Under 70	24	22	7	3	2	2	1	1	1	60	1,517	
70 to 139	14	22	11	4	6	2	4	2	2	61	2,199	
140 to 179	16	19	17	11	6	1	4	1	2	77	2,648	
180 to 219	2	10	14	3	5	2	1	1	2	36	2,576	
220 to 259	2	7	8	3	4	1	7	3	2	28	3,509	
260 and over	4	18	9	4	2	3	7	3	2	52	3,483	
Total	62	98	66	28	25	9	12	8	6	314	2,551	
Electrified after Jan. 1, 1943												
Under 70	11	2	1	1	3	1	1	1	1	16	1,298	
70 to 139	30	15	4	3	3	1	1	1	1	52	1,232	
140 to 179	14	11	1	3	1	1	1	1	1	29	1,226	
180 to 219	8	12	2	2	1	1	1	1	1	23	1,470	
220 to 259	5	3	3	2	1	1	1	1	1	11	1,327	
260 and over	3	9	2	2	1	1	7	3	2	16	2,007	
Total	71	52	13	4	5	1	12	1	6	147	1,367	
All electrified farms												
Under 70	35	24	8	4	2	2	1	1	1	76	1,471	
70 to 139	44	37	15	14	9	9	1	4	2	113	1,754	
140 to 179	30	30	18	14	6	1	1	1	2	106	2,259	
180 to 219	10	22	16	3	6	2	2	1	2	59	2,145	
220 to 259	7	10	11	3	4	1	1	1	2	39	2,894	
260 and over	7	27	11	4	3	3	7	4	2	68	3,136	
Total	133	150	79	32	30	10	12	9	6	461	2,174	

TABLE 36.—*Characteristics of electrified farms by size of farm, 1947*

Characteristic	Unit	Size of farm group in acres						All farms
		Under 70	70-139	140-179	180-219	220-259	260 and over	
Farms represented.....	Number	76	113	106	59	39	68	461
Electricity consumed.....	Kw.-hrs.	1,471	1,754	2,259	2,145	2,894	3,136	2,174
Acreage operated.....	Acres	20	103	159	194	237	372	165
Acreage in crops.....	do.	6	70	114	126	160	236	109
Income:								
Gross farm.....	Dollars	1,490	6,861	10,125	12,001	14,924	19,818	9,977
Off-farm.....	do.	3,074	285	291	309	42	305	732
Total income.....	do.	4,564	7,146	10,416	12,310	14,966	20,123	10,709
Animal units.....	Number	7.10	30.81	39.55	46.71	60.53	81.95	41.01
Farms:								
Type:								
Hog.....	do.	14	67	62	40	22	37	242
Beef-hog.....	do.	2	9	12	7	5	12	47
Cash-crop.....	do.	4	12	15	5	9	14	59
General ¹	do.	11	24	17	7	3	5	67
Noncommercial ²	do.	45	1					46
Tenure:								
Full owner.....	do.	59	69	46	24	11	15	224
Part owner.....	do.	2	5	9	12	10	25	63
Tenant.....	do.	15	39	51	23	18	28	174
Multiple dwelling:								
Two wired.....	do.	1		9	7	4	24	45
Three wired.....	do.				1		1	2

¹ Includes 57 general farms, 4 poultry farms, and 6 dairy farms.² Includes 31 farms producing mainly for household use and 15 rural residences.

SIZE OF LIVESTOCK ENTERPRISE AND USE OF ELECTRIC EQUIPMENT

Certain relationships between the sizes of some livestock and poultry enterprises and the use of electrical equipment were evident from the collected data.

Electric brooders for chicks, for example, were used on 23 percent of the farms that raised fewer than 100 chicks in 1947, but they were more frequent on farms that were producing from 100 to 599 chicks; 56 percent of these farms had one or more of them. They were less frequent on farms raising 600 chicks or more as only 33 percent had electric chick brooders (table 39).

Seventy percent of all chick brooders used on the farms were electric, but on farms raising from 100 to 599 chicks about 73 percent were electric; about 55 percent on farms raising 600 or more were electric.

Complete information on brooding practices was not obtained, but it appears that on farms raising less than 100 chicks, most of the brooding was done with hens. For the average size of farm flock—those ranging from 100 to 599 chicks—mechanical brooding was preferred, especially with electrically heated hovers. Farms raising many chicks, 600 or more, used artificial heat for brooding but used a smaller proportion of electrically heated brooders.

Three-fourths of the nonelectric brooders burned oil or kerosene, a fifth burned coal, and the remainder used wood.

The electric chick brooders on these farms cost the farmers an average of about \$35 each. This was the average for a period of years rather than for the year of the survey.

TABLE 37.—*Characteristics of farms electrified before Jan. 1, 1943, by size of farm, 1947*

Characteristic	Unit	Size of farm group in acres						All farms
		Under 70	70-139	140-179	180-219	220-259	260 and over	
Farms represented.....	Number.....	60	61	77	36	28	52	314
Electricity consumed.....	Kw.-hrs.....	1,517	2,199	2,648	2,576	3,509	3,483	2,551
Acreage operated.....	Acres.....	20	100	159	194	238	384	169
Acreage in crops.....	do.....	7	68	116	132	161	252	114
Income:								
Gross farm.....	Dollars.....	1,600	6,961	10,755	13,712	16,783	20,538	10,765
Off-farm.....	do.....	3,355	285	376	171	52	370	874
Total income.....	do.....	4,955	7,246	11,131	13,883	16,835	20,908	11,639
Animal units.....	Number.....	7.48	31.92	40.18	48.36	66.92	81.86	42.55
Farms:								
Type:								
Hog.....	do.....	12	36	45	23	17	28	161
Beef-hog.....	do.....	1	8	10	7	5	7	38
Cash-crop.....	do.....	3	5	10	2	6	13	39
General ¹	do.....	8	12	12	4		4	40
Noncommercial ²	do.....	36						36
Tenure:								
Full owner.....	do.....	49	42	33	16	9	11	160
Part owner.....	do.....	2	2	7	9	9	20	49
Tenant.....	do.....	9	17	37	11	10	21	105
Multiple dwelling:								
Two wired.....	do.....	1		7	6	4	21	39
Three wired.....	do.....				1		1	2

¹ Includes 35 general farms, 3 poultry farms, and 2 dairy farms.² Includes 25 farms producing mainly for household use and 11 rural residences.TABLE 38.—*Characteristics of farms electrified after Jan. 1, 1943, by size of farm, 1947*

Characteristic	Unit	Size of farm group in acres						All farms
		Under 70	70-139	140-179	180-219	220-259	260 and over	
Farms represented.....	Number.....	16	52	29	23	11	16	147
Electricity consumed.....	Kw.-hrs.....	1,298	1,232	1,226	1,470	1,327	2,007	1,367
Acreage operated.....	Acres.....	18	106	161	194	236	330	155
Acreage in crops.....	do.....	5	72	108	118	160	186	98
Income:								
Gross farm.....	Dollars.....	1,077	6,744	8,453	9,323	10,192	17,478	8,294
Off-farm.....	do.....	2,022	285	67	524	16	92	428
Total income.....	do.....	3,099	7,029	8,520	9,847	10,208	17,570	8,722
Animal units.....	Number.....	5.68	29.51	37.88	44.13	44.28	82.27	37.70
Farms:								
Type:								
Hog.....	do.....	2	31	17	17	5	9	81
Beef-hog.....	do.....	1	1	2			5	9
Cash-crop.....	do.....	1	7	5	3	3	1	20
General ¹	do.....	3	12	5	3	3	1	27
Noncommercial ²	do.....	9	1					10
Tenure:								
Full owner.....	do.....	10	27	13	8	2	4	64
Part owner.....	do.....		3	2	3	1	5	14
Tenant.....	do.....	6	22	14	12	8	7	69
Multiple dwelling:								
Two wired.....	do.....			2	1		3	6

¹ Includes 22 general farms, 1 poultry farm, and 4 dairy farms.² Includes 6 farms producing mainly for household use and 4 rural residences.

TABLE 39.—*Electric and other chick brooders on farms in April 1948, by number of chicks raised in 1947*

Number of chicks raised	Farms	Farms using chick brooders		Chick brooders	
		Electric	Other	Electric	Other
	Number	Number	Number	Number	Number
None.....	106	0	0	0	0
Under 100.....	17	4	2	4	2
100 to 199.....	41	17	11	17	11
200 to 399.....	171	101	35	104	35
400 to 599.....	83	48	18	49	18
600 to 4,200.....	43	14	13	23	19
Total.....	461	184	79	197	85

Electric brooders for pigs were used on 17 percent of the farms that raised pigs in the spring of 1947. They were used on 7 percent of the farms raising less than 25 pigs, on 16 percent of the farms raising from 25 to 99 pigs, and on 27 percent of the farms raising 100 or more pigs. Only 1 brooder that was not electric was used on the 461 farms in the survey (table 40).

Most farms that had pig brooders had more than one. Farms that had these brooders and raised from 25 to 99 pigs in the spring of 1947 averaged 4 brooders to a farm. This number increased to 8 brooders per farm for those using brooders and raising 100 pigs or more. Most of the brooders used were home-made and cost an average of about \$4.50 each.

The practice of brooding pigs by means of electricity is spreading rapidly. Apparently, the first electric pig brooder on one of these farms was installed in 1942.

All the reported milking machines were operated by electric motors. The percentage of farms using these machines increased as the number of cows milked per farm increased. Less than 2 percent of the farmers who milked 3 cows or less had a milking machine and 9 percent of those who milked 4, 5, or 6 cows had one. Above this number of cows, the percentage of farms with milking machines increased rapidly—45 percent of the farms with 7, 8, or 9 cows, 49 percent of those with 10 to 14 cows, and 78 percent of those with 15 to 35 cows (table 41). The numbers of cows reported were for the year 1947, which might have been

TABLE 40.—*Electric and other pig brooders on farms in April 1948, by number of pigs raised in the spring of 1947*

Number of pigs raised	Farms	Farms using pig brooders		Pig brooders	
		Electric	Other	Electric	Other
	Number	Number	Number	Number	Number
None.....	86	0	0	0	0
Under 25.....	60	4	0	9	0
25 to 49.....	80	14	0	42	0
50 to 74.....	94	14	0	58	0
75 to 99.....	57	8	1	32	1
100 to 375.....	84	23	0	183	0
Total.....	461	63	1	324	1

TABLE 41.—Farms using specified dairy equipment in April 1948, by size of dairy enterprise in 1947

Number of cows milked	Farms	Farms using—							
		Cream separator		Milking machine		Milk cooler		Water heater	
		Electric	Other	Electric	Other	Electric	Other	Electric	Other
None	Number	0	0	0	0	0	0	0	0
1 to 3	62	57	36	2	0	2	1	1	1
4 to 6	129	91	9	10	0	1	2	3	3
7 to 9	114	56	6	31	0	0	4	0	0
10 to 14	69	50	2	27	0	0	4	3	1
15 to 35	55	22	0	25	0	2	3	9	1
	32								
Total	461	276	53	95	0	2	14	21	8

different from the number milked when the equipment was installed. The milking machines were reported to have cost an average of about \$250.

Cream separators were used on 71 percent of the farms. More than four-fifths of these were operated by electric motors; the remainder were run by hand. The percentage of farms with electrically operated cream separators increased from 44 percent of those milking 3 cows or less to 91 percent of those milking from 10 to 14 cows. For farms milking 15 cows or more, the number that had electrically operated cream separators dropped to 69 percent, possibly because most of them sold whole milk instead of cream. The number of hand-operated cream separators declined as the number of cows milked increased.

Of the water heaters used in connection with the dairy enterprise, almost three-fourths were electric. There was a direct relation between the number of cows milked and the percentage of farms having an electrically operated water heater. Less than 1 percent of the farms with 1, 2, or 3 milk cows had such a heater while 28 percent of those with 15 or more milk cows had one each.

The 8 nonelectric water heaters were of different kinds. Coal, wood, kerosene, oil, and gas fuels were reported.

Milk coolers operated by electricity were reported by 2 farms. One of these had 17 cows and the other had 20. Fourteen other milk coolers were used; cool water pumped from a well was the only cooling agent reported.

TENURE OF OPERATOR AND USE OF ELECTRICITY

No appreciable differences were found in the average consumption of electric energy on farms in this area that could be attributed directly to differences in the tenure status of the operators.

The commercial farms that had been electrified for 5 years or more and that were operated by full owners used an average of 2,578 kilowatt-hours in 1947; the tenant-operated farms used 2,633 kilowatt-hours. Not only were the two groups similar in average consumption but the distribution of farms among the high-, average-, and low-consuming classes was similar (table 42). The total incomes of the tenant-operated farms averaged somewhat higher than those of the full owner-operated farms (table 43). But it seems probable that the net incomes of the two groups were more nearly comparable than were their total incomes. Approximately 36 percent of the gross farm income of the tenant-operated farms left those farms as payment of rent. An unknown part of the income of the farms that were operated by full owners left the farm in the form of service charges on debts, taxes, and costs of improvement and maintenance. Data are not available to confirm the observation but it is probable that a larger part of the total incomes of the owner operators than of the tenant operators remained on the farms as net or disposable income.

On the tenant-operated commercial farms most of the electrically powered equipment that could not be moved easily was owned by the landlord. Included were such equipment as pumps on water systems, and motors on milking machines and on grain elevators. As a rule, household appliances were owned by the tenants. Most of these are

TABLE 42.—Number of commercial farms electrified before January 1, 1943, by electricity consumed and by tenure, 1941

Tenure	Farms using indicated kilowatt-hours								Farms	Average consumption per farm
	Less than 1,000	1,000 to 1,999	2,000 to 2,999	3,000 to 3,999	4,000 to 4,999	5,000 to 5,999	6,000 to 6,999	7,000 to 7,999	8,000 and over	
	Number	Number	Number	Number	Number	Number	Number	Number	Number	kw.-hrs.
Full owner	25	41	29	12	11	3	4	5	3	2,578
Part owner	3	13	11	8	3	3	4	2	1	3,280
Tenant	16	32	24	6	9	3	4	1	2	2,633
Total	44	86	64	26	23	9	12	8	6	2,718
Tenant:										
Cash	4	9	1	1	2	1	1			2,218
Crop-share	6	10	12	3	2	2	1		1	2,589
Livestock-share	6	13	11	2	5		2	1	1	2,867
Total	16	32	24	6	9	3	4	1	2	2,633

TABLE 43.—*Characteristics of commercial and noncommercial farms electrified before January 1, 1943, by tenure of operator, 1947*

Characteristic	Unit	Operator tenure						All farms
		Full owner	Part owner	Tenant			Share of livestock and products	
				All	Cash	Share of crops		
Farms represented.....	Number.....	133	48	97	19	37	41	278
Electricity consumed.....	Kw.-hrs.....	2,578	3,280	2,633	2,218	2,589	2,867	2,718
Acreage operated.....	Acres.....	153	253	209	147	219	229	190
Acreage in crops.....	do.....	95	178	150	101	173	153	129
Income:								
Gross farm.....	Dollars.....	9,859	16,590	12,986	10,159	13,086	14,206	12,111
Off-farm.....	do.....	597	549	202	231	342	64	451
Total income.....	do.....	10,456	17,139	13,188	10,390	13,428	14,270	12,562
Animal units.....	Number.....	43.38	59.14	48.04	35.33	38.28	62.75	47.73
Farms:								
Type:								
Hog.....	do.....	78	29	54	10	14	30	161
Beef-hog.....	do.....	21	8	9	2	2	5	38
Cash-crop.....	do.....	11	8	20	4	14	2	39
General 1.....	do.....	23	3	14	3	7	4	40
Multiple dwelling:								
Two wired.....	do.....	12	11	15	2	7	6	38
Three wired.....	do.....		1	1			1	2
Noncommercial farms ²								
Farms represented.....	do.....	27	(³)	8	8			36
Electricity consumed.....	Kw.-hrs.....	1,364		805	805			1,260
Acreage operated.....	Acres.....	8		4	4			8
Acreage in crops.....	do.....	2						1
Income:								
Gross farm.....	Dollars.....	402		227	227			366
Off-farm.....	do.....	4,405		3,123	3,123			4,140
Total income.....	do.....	4,897		3,350	3,350			4,506
Animal units.....	Number.....	3.00		1.16	1.16			2.58
Multiple dwelling farms:	do.....	1						1
Two wired dwellings.....								

¹ Includes 35 general farms, 3 poultry farms, and 2 dairy farms.² Includes 25 farms producing mainly for household use and 11 rural residences.³ Only 1 farm in this class.

readily movable, and could be used on any electrified farm to which the family might move.

Historically there was little difference in the use of electric energy by the full owners as a group and the tenants as a group. For each of the 10 years of record, the average consumption of the two groups was similar (table 44).

Farms that were partly owned and partly rented by the operators had an average consumption of 3,280 kilowatt-hours or more than either of the other two tenure groups. The part-owned farms, however, were larger and the incomes on these farms were considerably higher than those of either of the other groups (table 43). These conditions usually mean a larger consumption of electricity per farm in the area, and it was so here.

In the sample were 278 commercial farms that had been electrified for 5 years or more. Of these, 133 were operated by the owners, 48 were farmed by part owners, and 97 were operated by tenants. In the tenant group, 41 were operated under livestock-share leases, 37 under crop-share agreements ¹⁸, and 19 under all-cash contracts.

TABLE 44.—Consumption of electric energy per farm on commercial farms electrified before Jan. 1, 1943, and farms represented, by 1947 tenure of operator, 1938-47

Year	Tenure of operator			All farms
	Full owner	Part owner	Tenant	
	<i>Kw.-hrs.</i>	<i>Kw.-hrs.</i>	<i>Kw.-hrs.</i>	<i>Kw.-hrs.</i>
1938.....	831	963	797	839
1939.....	929	1,069	849	925
1940.....	905	1,038	920	935
1941.....	1,042	1,260	992	1,067
1942.....	1,112	1,332	1,113	1,154
1943.....	1,273	1,557	1,298	1,331
1944.....	1,454	1,650	1,428	1,479
1945.....	1,620	1,888	1,584	1,654
1946.....	1,961	2,284	1,850	1,978
1947.....	2,578	3,280	2,634	2,718
Farms represented				
	<i>Number</i>	<i>Number</i>	<i>Number</i>	<i>Number</i>
1938.....	29	11	27	67
1939.....	42	16	32	90
1940.....	71	27	45	143
1941.....	105	42	73	220
1942.....	118	48	91	257
1943.....	130	48	97	275
1944.....	131	48	97	276
1945.....	131	48	97	276
1946.....	133	48	97	278
1947.....	133	48	97	278

The average consumption of electric energy in 1947 by the commercial farms that were cash rented was 2,218 kilowatt-hours (table 43). The crop-share rented farms averaged 2,589 kilowatt-hours and the livestock-share operated farms averaged 2,867 kilowatt-hours. Apparently some of these differences might be rooted in the tenure situation

¹⁸ Leases calling for cash or privilege rent for a part of the farm and for crop-share rent for the remainder were classified as crop-share leases or agreements. For most of the farms so leased the cash rent paid was a relatively small (but undetermined) part of the total rent paid.

for livestock-share rented farms have a smaller rate of turn-over of occupants than do either of the other groups and the highest rate of turn-over is found in the cash-rented group. On the other hand, the cash-rented farms were the smallest and the livestock-share rented farms the largest of these three groups. The cash-rented farms averaged 147 acres, the crop-share rented farms 219, and the livestock-share rented farms 229 acres. Gross farm incomes from these commercial farms were roughly in ratio to the acres operated. Off-farm income was small in all of the groups; it was of less importance on livestock-share operated farms than in either of the other groups.

It seems reasonable, therefore, to attribute the differences in the amounts of electric energy used on these commercial farms largely to differences in incomes and sizes of farms rather than to differences in operator tenure.

It was observed that, in the main, the tenants were younger than the owners and, as a general rule, the younger men were better acquainted with mechanical devices than the older men. They were generally more willing to adopt labor-saving equipment, and more readily thought of electrically powered household appliances as necessities rather than as luxuries. This propensity on the part of the younger farmers may offset to a considerable degree the effect of somewhat higher disposable incomes of older owner-operators on the consumption of electric energy. However, no specific data were gathered on the subject.

Two characteristics were common to all the noncommercial farms that had been electrified for 5 years or more. The acreages were small and the gross farm incomes were low. The people living on these tracts were heterogeneous as to employment and interests. Some were business men who looked on their farms as country homes, some were retired farmers who still lived on their farms but rented out their farm land, some were widows, and some were laborers in the towns and cities. Of these noncommercial tracts, 27 were owner-operated, 1 was part-owned (the owner rented a small plot for corn), and 8 were rented for cash. This number is too small to permit use of the averages for generalizations concerning tenure.

FARMER ATTITUDES TOWARD ELECTRICITY

Interviewed farmers usually gave high tribute to electricity for making farm life more pleasant and farm work less laborious. Individual responses ranged from some who considered it to be mainly a convenience to those who said they would be more willing to do without a car or a hard-surfaced road than without electricity. Lighting in the home and in the service buildings received the greatest appreciation, with water systems a close second.

Typical expressions regarding electrification were: "Electricity is the best hired man I ever had," "Operator's chore boy," "Big help to farmers who make use of it," "Brings farmer to town and makes the farm the best place in the world to live," "Greatest thing that ever happened in farming," "Electricity is essential in these days of labor shortage," and "Would not be without it at any cost."

Eighty-three farmers made estimates as to the dollar value of electricity to farms. These estimates were based on the assumption that one farm was electrified while another did not have the service and

could not get it. Estimates ranged from \$1 or \$2 an acre to \$500 an acre on one small farm. Most of them ranged from \$20 to \$25 an acre, or between \$3,000 and \$4,000 for a 160-acre farm. Two tenants said they would pay \$500 more yearly rent for a farm with electricity than for one without.

People with certain physical disabilities found electricity to be especially valuable. A man with some fingers missing said he could not keep his large dairy herd without his milking machine. Others with handicaps that limited their physical output, as heart trouble, said they could continue farming because electricity lightened their tasks.

Some operators—owners and tenants alike—said they would not farm without electricity. A few tenants said they wanted to expand their use of electricity but did not feel justified in putting in the necessary wiring at their own expense.

Two percent of the interviewed farmers reported that their power-line service was unsatisfactory. Conditions complained about were interruptions in service ranging from several hours to 2 or 3 days and lack of power, particularly in late afternoons. Another 6 percent of the farmers said their service had been satisfactory but that there had been interruptions in service which they considered serious. In general, farmers who used electricity for several purposes—as in preparing food, heating water, pumping water, and brooding chicks—were more likely to classify a specific interruption as serious than were farmers who had few uses for it.

About 4 percent of the farmers said they considered their power supply to be unreliable for some specific purposes. They mentioned milking cows, brooding chicks, and operating home freezers, water heaters, and kitchen ranges. Here again, there was considerable variation in the responses of farmers in a specific community or even on adjoining farms.

An interruption at milking time would cause considerable inconvenience to a farmer who milked 12 or 15 cows with a milking machine, but the same interruption might not greatly inconvenience one who milked only 2 or 3 by hand. Likewise, an interruption of several hours during the chick brooding season would be more troublesome to a farmer who used an electric brooder than to one using some other kind. As farmers depend increasingly on the electric power line as a source of power for essential purposes, prolonged interruptions in service will have increasingly costly effects.

LABOR SAVINGS REPORTED

Practically all of the farmers seemed confident that electricity had brought about labor savings on their farms but most of them were reluctant to make estimates of the extent to which labor was saved or what uses of electricity resulted in the saving. But some estimates were made regarding the saving of labor by using milking machines, cream separators, brooder hovers for chicks, and stock-tank heaters.

Of the 95 farmers who had milking machines, 90 made estimates of the labor saved daily as compared with milking by hand (table 45). The estimates ranged from no time saved on farms with a few cows to several hours each day on farms with large herds. The average of the

90 estimates was a trifle over 1 hour saved each day per farm; the average number of cows milked per farm was 10.75.

Based on the number of farms in the sample with milking machines, it is estimated that 7,800 milking machines were in use in 1947 on farms in the 19 counties of the study area. If each of these machines saved 1 hour of labor each day the total saving that year was 7,800 hours daily, or the equivalent of 780 men each working 10 hours a day.

Electrically driven cream separators were reported on 276 of the 461 farms in the sample. Of these, 260 farmers made estimates of the time saved by using electric power rather than man-power to operate the equipment. The average estimate of time saved was 20 minutes a day. Some saving of time was estimated by 191 operators. No saving of time was estimated by 69 of the operators but many of them said there was a saving of energy at least.

TABLE 45.—Number of farms reporting labor saved and reporting no labor saved by use of electrical equipment, and method of doing jobs before electrification, 1947

Item	Unit	Cream separator	Milking machine	Brooder hover	Tank heater
Farms:					
Reporting labor saved over indicated method:					
Hand.....	Number..	188	78		
Gas engine.....	do.....	2	1		
Water.....	do.....	1			
Oil.....	do.....			69	12
Coal.....	do.....			16	7
Wood.....	do.....			2	5
Hens.....	do.....			10	
Amount not reported.....	do.....	0	0	7	4
Total.....	do.....	191	79	104	28
Reporting no labor saved over indicated method:					
Hand.....	do.....	68	11		
Gas engine.....	do.....	1	0		
Water.....	do.....	0			
Oil.....	do.....			30	6
Coal.....	do.....			4	2
Wood.....	do.....			0	1
Hens.....	do.....			2	
Total.....	do.....	69	11	36	9
Not reporting on labor saved ¹	do.....	16	5	44	11
Total farms.....	do.....	276	95	184	48
Average days equipment was used.....	do.....	365	365	55	75
Time saved by use of electricity:					
Per farm reporting.....	Man-hours	123	405	35	46
Per day of use.....	do.....	.33	1.11	.64	.61

¹ Some farms had no prior methods for comparison because the equipment had not been used before or the enterprise was new and electric equipment was the first used. Some had not farmed before and some did not report length of time used.

Stock-tank heaters using electric energy were reported on 48 farms, 37 of which made estimates of labor saved by using this heater instead of the previous one which burned coal, oil, or other fuel. The average of the estimates was between 30 and 40 minutes a day for the 75 days or thereabouts that the heater was used.

Electrically heated brooder hovers for chicks were reported on 184 farms, 140 of which made similar estimates. The average of these was

TABLE 46.—Farms having specified electrical equipment and methods of doing jobs before electrification, 1947

Item	Farms using electric—								
	Milking machine	Cream separator	Dairy water heater	Poultry water warmer	Brooder hover	Pig brooder	Tank heater	Grain elevator	Corn sheller
Farms represented	Number	Number	Number	Number	Number	Number	Number	Number	Number
Method of doing job before use of electricity:									
Hand	95	276	21	83	184	63	48	44	32
Oil	89	256	2	27	121	1	20	3	14
Gas			1						
Wood									
Coal					2		6		
Hens					20		10		
Water		1			12				
Hot water jug						2			
Basket in house						1			
Later litters						1			
Stove			4			1			
Light bulbs				1					
Warm water from house				1					
Hot plate			1						
Gas engine	1	3						3	1
Custom work								1	
Horses								2	4
Tractor								7	13
None reported ¹	5	16	13	54	29	56	12	28	18

¹ Some farms had no prior methods because the enterprise was new and others did not report the prior methods.

almost 40 minutes a day during the brooding season. The average length of time the brooders were used was 55 days a year.

Electric brooders for chicks, it is estimated, were used on 15,000 of the 37,850 electrified farms in the study area in 1947. Based on the estimated time saved daily, as given by the farmers in the survey, the use of these brooders resulted in a saving of 9,600 man-hours daily during the brooding season.

Two-thirds of the farms with electric chick brooders had previously used oil-burning brooders and 11 percent had used coal (table 46). Apparently the fear that fire might be set by the oil and coal brooders caused the farmer, or his wife, to make many more trips to the brooder house each day than when electric brooders were used. Time previously used to provide fuel and keep up the fire was saved. On the other hand, interruptions in service on the power lines caused some trouble to those using electric brooders, and deterred some others from using them.

The general feeling among farmers who handled a substantial number of livestock was that lighting in the service buildings and service areas saved time, although they made no estimates of the amount saved. Most of the interviewed farmers apparently believed that electricity in the dwelling also saved time and labor, but here again, no estimates were made of the amount.

Comments by farmers who used electric brooders for pigs indicated that, as a rule, they believed the brooders enabled them to farrow their pigs earlier, raise more pigs per litter, and sell them on an earlier market than was true before they used the brooders. Some farmers who used electric brooders for chicks, especially those who had previously used hens, thought the brooders enabled them to start their chicks earlier in the spring. For both pieces of equipment, however, the farmers were reluctant to make positive statements as to any changes in the timing of production.

Some farmers said electrification had meant saving in labor and benefits from timeliness in doing some jobs, because these jobs had been taken over, wholly or partly, by the women and children of the family.

It is evident that a complete understanding of the effect of electrification on the farm organization and the requirements for labor may be had only from more intensified research.

FUTURE USE OF ELECTRICITY

Within another 10 years or so, perhaps by 1960, farmers in the area are likely to be using 4,500 or more kilowatt-hours of electricity per farm per year. This would be more than twice the 2,174 kilowatt-hour average of 1947 and would result in a total consumption for all farms in the area of $2\frac{1}{2}$ times the consumption in 1947. This estimate of possible usage about 10 years hence is not supposed to be exact; it is made at this time as a means of indicating that potentialities for using much more electricity in this area are in evidence.

This estimate was made by (1) extending into the future the consumption trends of the last 10 years, (2) making estimates of the number of the different kinds of electric equipment that may be in use on farms by about 1960 and from these estimates building up an estimate of

probable total usage, and (3) examining all the results for reasonableness. A brief discussion of the process is in order.

Two trend lines calculated from the consumption data for the decade of record were projected to 1960. One line was based on the percentage changes in consumption from one year to the next, the other on the average annual increase in kilowatt-hours used per farm. For both trend lines the records of the older electrified farms were used, because apparently by 1960 practically all the farms in the area will have been electrified for some years.

As previously developed in this analysis, the older electrified farms increased their consumption of electricity at the rate of 10.7 percent per year in the decade of record.¹⁹ If this trend continues until 1960 the average annual consumption per farm would be about 8,400 kilowatt-hours, compared with an average consumption of 2,174 kilowatt-hours in 1947. It is possible that this level of consumption could be reached if home heating and some other uses for electricity advance from the experimental stage, and become practical realities. It does not seem probable however that this equipment will be perfected, manufactured, and installed in large numbers in the near future. A much lower estimate seems more reasonable at this time.

Projection of the trend line based on average annual increase in kilowatt-hours consumed results in a projected consumption that is much more conservative. During the period 1938-47, the older electrified farms increased their consumption at the rate of 152.86 kilowatt-hours per year.²⁰ If this trend is continued to 1960 it would show that the farms used an average of about 4,200 kilowatt-hours at that time (fig. 8). This projection appears more reasonable than the one previously described, especially when viewed from the standpoint of the equipment that may be in use by 1960.

Farmers in the area have bought large quantities of many kinds of electrical equipment, but with few exceptions the number of farms that lack some important pieces of equipment is greater than the number of farms that have these pieces. Furthermore, some pieces of equipment that are high consumers of electricity, as freezer cabinets and air-conditioning units, are still in the early stages of use. Existing uses not now found in this area, as television, and uses that are in the experimental stage, as home heating, will tend to augment future consumption.

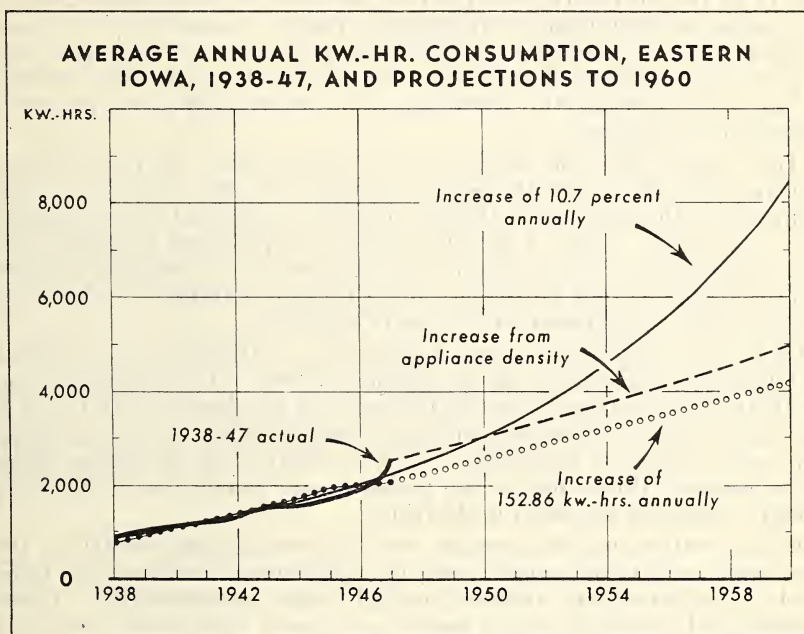
These pieces of equipment and devices are bound to increase in the area, as they are improved and are more readily available, as power lines are extended, and as service from the power lines is improved. Although the exact number of the different kinds of electrical devices that will be used on farms by 1960 cannot be foretold, estimates were made of appliance densities that may prevail at that time. From these, the average amount of electricity the farms may be expected to use at that time was calculated. Consideration was given to the number of farms of high, medium, and low incomes, to the farms with two or more dwellings, to the number of commercial and noncommercial farms, to the sizes of the principal livestock and poultry enterprises on individual

¹⁹ A fitted trend curve $Y_c = 895 (1.107^x)$; 1938=0. Y_c is the calculated kilowatt-hours and x is the number of years after 1938.

²⁰ A straight-line trend computed by the least squares method $Y_c = 792 + 152.86 X$; 1938=0. Y_c is the calculated kilowatt-hours and X is the number of years after 1938.

farms, to the rates at which farmers have acquired specific kinds of equipment in recent years, and to trends in construction of farm buildings in the area.

Several assumptions must necessarily condition any estimated projection of this kind. Implicit in the projections here made are four that are important: (1) That distribution lines in the area will be extended until the service is available to virtually all farms; (2) that the power available to the farms will be adequate for their needs and that the cost of electricity to the farm will compare favorably with the costs of



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FIGURE 8.—As indicated by the two lower lines on the chart it seems reasonable to expect that farmers in the area will be using an average of 4,000 to 5,000 kilowatt-hours within the next 10 years. In 1947, they used about 2,200 kilowatt-hours per farm.

competing kinds of energy; (3) that farm income will remain at a reasonably high level, that is, that there will be no serious depression, and (4) that there will be no revolutionary technological advances during the period that will affect equipment using either electricity or a competing kind of energy. These are assumptions; they are not predictions.

Based on estimates of the probable densities of equipment in 1960, the average annual consumption per farm may be almost 5,000 kilowatt-hours. To reach this consumption, 14,000 farms in the area will have installed water systems, 3,800 will have acquired milking machines, 11,000 will have begun to use electric pig brooders, 9,800 will have installed electric chick brooders, and 7,000 will have begun using electric motors to elevate grain. All of these will be in addition to replacements

for the items now on the farms. In the farm homes a wide variety of new electrical equipment will have been installed, besides replacements. Included will be about 15,000 refrigerators, 11,000 electric ranges, 12,000 washing machines, 16,000 vacuum cleaners, 5,000 air-conditioning units, and thousands of clocks and other miscellaneous items.

Even though many kinds of equipment are likely to be installed in this period, probably a comparatively few pieces of household equipment will use a large part of the electricity consumed on the farms. The estimates of probable densities of equipment indicate that about half of all the electricity to be used on the farms in 1960 will be used by five pieces of equipment—refrigerators, ranges, water heaters, freezer cabinets, and air-conditioning units. Farm-production purposes may require about a fourth of the total. The remaining fourth will probably be used for lighting the dwellings and for operating miscellaneous household equipment.

This means that the accuracy of this projection on the probable consumption of electricity depends largely on the accuracy of the estimates of the densities of the few pieces of equipment that are heavy users of energy. Most of the other kinds of equipment considered are well established in the area and can be expected to increase in number as in the past, as new farms are electrified and as those now electrified become more accustomed to the use of electricity.

Of the five important users of electricity, refrigerators were found on 80 percent of the farms in the sample, in 1947. It is estimated that by 1960 electric refrigerators will be in use on 95 percent of all farms in the area. They use less electricity per unit than do any of the other four major pieces of equipment. Their adoption by additional farms seems assured; this is one of the pieces of equipment that is generally bought soon after the farm is electrified.

Water heaters, on the average, were consuming more electricity per year than any other single piece of equipment considered in 1947. Their use requires water systems to supply water automatically. Water systems and automatic water heating are much wanted by farmers of eastern Iowa and installation may be expected to be rapid. In 1947, 54 percent of the electrified farms had water systems and almost half of these had water heaters. Some farms had more than one heater. Considering the number of dwellings, the number of farms having more than one water system, and the trend of installation over the last 10 years, it was estimated that 80 percent of the farms in the area will have water systems by 1960, and that about 50 percent of these (about the same proportion as in 1947) will be using electric water heaters. The importance of this estimate is evident when it is realized that its fulfillment could mean that water heaters may then be using from 20 to 25 percent of all electric energy used by farmers in the area.

Electric ranges are heavy consumers of electricity. In 1947, 33 percent of the older electrified farms were using electric ranges. Among the many who were using gas and coal ranges, some will switch to electricity within the next few years. It is estimated that nearly half (45 percent) of all the farms in the area will be using electric ranges by 1960, compared with 27 percent using them in 1947. If this increase materializes, ranges on farms in the area will be using around 26 million kilowatt-hours of electricity in 1960, compared with 38 or 39 million

kilowatt-hours being used by water heaters, and 16 million kilowatt-hours for operating electric refrigerators.

Use of hot plates is expected to continue to increase because of their adaptability to summer use.

Freezer cabinets were just beginning to be used in the area in 1947. Ten percent of the electrified farms had one or more. It is estimated that about 35 percent of all farms in the area will be using freezer cabinets at the end of another 10 years. Freezers on these farms then will probably be using about 17 million kilowatt-hours per year, or almost 8 percent of the total.

Air conditioning in the farm homes of the area is new. Less than 1 percent of the farms reported using it in 1947. Several farmers indicated interest in air conditioning, but for the projections included herein a conservative figure of 15 percent of the farms of the area has been used. They might use around 13 million kilowatt-hours per year.

The extension of the trend line based on percentage changes from year to year results in a projected average annual consumption of 8,400 kilowatt-hours by 1960, as mentioned before. It does not now appear reasonable to expect that enough appliances will be in use by that time to permit this volume of consumption. On the other hand, the extension of the trend line based on the average amount of electricity used each year for the decade 1938-47 results in a projected consumption of 4,200 kilowatt-hours by 1960. This is only a little less than the projected consumption of almost 5,000 kilowatt-hours, an estimate which was developed by listing the probable uses that may be made of electricity in 1960. The estimate of 4,500 kilowatt-hours as a minimum for 1960, which is used herein, is about half way between these two projections.

APPENDIX TABLES

TABLE 47.—*Land use, crop yields, and tractors per farm, by income groups, 1947*¹

Item	140 low-income farms			227 medium-income farms			94 high-income farms			All 461 farms		
	Average per farm		Yield per acre	Average per farm		Yield per acre	Average per farm		Yield per acre	Average per farm		Yield per acre
	All farms	Farms reporting		All farms	Farms reporting		All farms	Farms reporting		All farms	Farms reporting	
	Acres ²	Acres ²	Bushels	Acres ²	Acres ²	Bushels	Acres ²	Acres ²	Bushels	Acres ²	Acres ²	Bushels
Land use:												
Crops:												
Corn	21	32	28	53	58	34	96	100	35	52	62	34
Oats	9	19	25	24	27	24	40	46	34	22	30	28
Soybeans	5	22	13	10	24	17	28	46	18	12	31	17
			Tons			Tons			Tons			Tons
Red clover	4	13	1.3	12	20	1.5	16	28	1.6	10	21	1.5
Alfalfa	1	8	2.3	2	13	4.8	6	16	2.3	3	14	2.1
Other hay	3	18	1.3	3	17	1.4	3	21	1.7	3	18	1.4
Other crops	2	14		3	20		3	4		3	20	
Not harvested	1			3			8			4		
Total	46			110			201			109		
Open pasture	26	33		41	43		81	81		45	49	
Woodland	2	20		2	17		2	23		2	20	
Other land	6	6		9	10		16	16		9	10	
Total operated	80			162			300			165		
Tractors	Number	Number		Number	Number		Number	Number		Number	Number	
	0.7	1.1		1.2	1.3		2.0	2.0		1.2	1.4	

¹ See footnote 1, table 6.² Average crop acres harvested per farm.

TABLE 48.—Land use, crop yields, and tractors per farm, by type of farm, 1947

Item	242 hog farms			47 beef-hog farms			59 cash-crop farms			67 general farms ¹			46 noncommercial farms ²			All 461 farms		
	Average per farm		Yield per acre	Average per farm		Yield per acre	Average per farm		Yield per acre	Average per farm		Yield per acre	Average per farm		Yield per acre	Average per farm		Yield per acre
	All farms	Farms reporting		All farms	Farms reporting		All farms	Farms reporting		All farms	Farms reporting		All farms	Farms reporting		All farms	Farms reporting	
Land use:	Acres	Acres	Bushels	Acres	Acres	Bushels	Acres	Acres	Bushels	Acres	Acres	Bushels	Acres	Acres	Bushels	Acres	Acres	Bushels
Crops:																		
Corn.....	56	62	35	71	74	30	72	81	36	44	48	30	1	5	29	52	62	34
Oats.....	26	30	25	26	30	34	23	34	32	23	28	33	(*)	5	32	22	30	28
Soybeans..	8	25	17	19	28	17	36	51	17	8	19	15				12	31	17
			Tons			Tons			Tons			Tons						Tons
Redclover..	12	21	1.5	15	24	1.8	8	21	1.4	8	18	1.5				10	21	1.5
Alfalfa....	4	14	2.0	2	17	2.3	2	12	2.4	2	11	2.3	(*)	3	2.3	3	14	2.1
Other hay..	3	18	1.3	5	21	1.6	4	17	1.9	3	16	1.4	(*)	5	1.2	3	18	1.4
Other crops	2	16	xxx	4	31	xxx	6	28	xxx	1	17	xxx	1	20	xxx	3	20	xxx
Not harvested.....	4			2			9			3						4		
Total.....	115			144			160			92			2			109		
Open pasture.....	51	52		74	76		35	38		37	37		4	12		45	49	
Woodland.....	3	22		2	16		1	19		1	14		(*)	3		2	20	
Other land.....	8	9		15	16		12	14		9	10		3	3		9	10	
Total operated.....	177			235			208			139			9			165		
Tractors.....	Number	Number		Number	Number		Number	Number		Number	Number		Number	Number		Number	Number	
	1.3	1.4		1.7	1.7		1.5	1.6		1.2	1.3		.1	1.0		1.2	1.4	

¹ Includes 57 general farms, 4 poultry farms, and 6 dairy farms.² Includes 31 farms producing mainly for household use and 15 rural residences.

* Less than 0.5.

TABLE 49.—Number of specified kinds of livestock per farm, by income groups, 1947

Livestock	140 low-income farms		227 medium-income farms		94 high-income farms		All 461 farms	
	Average for all farms	Average per farm reporting	Average for all farms	Average per farm reporting	Average for all farms	Average per farm reporting	Average for all farms	Average per farm reporting
	Number	Number	Number	Number	Number	Number	Number	Number
Pigs:								
Raised:								
Spring	19	31	58	65	125	135	60	73
Fall	6	28	24	45	43	70	22	49
Bought and fed	1	17	5	56	14	102	6	58
Cattle and calves:								
Dairy:								
Cows	4	5	7	8	6	6	6	7
Heifers	1	3	3	4	2	5	2	4
Beef cows	1	7	3	11	8	16	4	12
Feeder cattle	1	9	6	20	29	49	9	32
Other	2	6	6	8	17	16	6	10
Sheep, stock	2	10	3	18	24	125	7	41
Horses and mules	1	3	2	2	2	3	2	3
Hens and pullets	106	127	160	173	144	166	140	159
Chicks hatched or bought ¹	188	274	316	366	331	493	280	364

¹ Includes a few turkeys.

TABLE 50.—Number of specified kinds of livestock per farm, by type of farm, 1947

Livestock	242 hog farms		47 beef-hog farms		59 cash-crop farms		67 general farms		46 noncommercial farms		All 461 farms	
	Average for all farms	Average per farm reporting	Average for all farms	Average per farm reporting	Average for all farms	Average per farm reporting	Average for all farms	Average per farm reporting	Average for all farms	Average per farm reporting	Number	Number
Pigs:	Number	Number	Number	Number	Number	Number	Number	Number	Number	Number	Number	Number
Raised:												
Spring-----	85	86	51	6	33	52	37	45	1	7	60	73
Fall-----	34	55	17	1	8	34	10	34	(1)	7	22	49
Bought and fed-----	4	51	13		13	109	7	56	-----	1	6	58
Cattle and calves:												
Dairy:												
Cows-----	6	7	6		4	5	9	9	1	2	6	7
Heifers-----	2	4	2		1	4	3	4	(1)	1	2	4
Beef cows-----	4	12	7		3	14	2	7	-----	-----	4	12
Feeder cattle-----	8	23	38		4	14	2	2	(1)	3	9	32
Other-----	7	10	8		5	10	6	25	(1)	2	6	10
Sheep, stock-----	3	16	45		1	16	4	18	1	8	7	41
Horses and mules-----	2	3	2		1	2	1	2	(1)	6	2	3
Hens and pullets-----	157	167	143		98	109	185	193	40	85	140	159
Chicks hatched or bought 1-----	320	381	255		235	315	339	392	68	195	280	364

2 Includes a few turkeys.

1 Less than 0.5.

TABLE 51.—*Estimated average amount of electricity required annually for lighting purposes and for operating specific equipment*¹

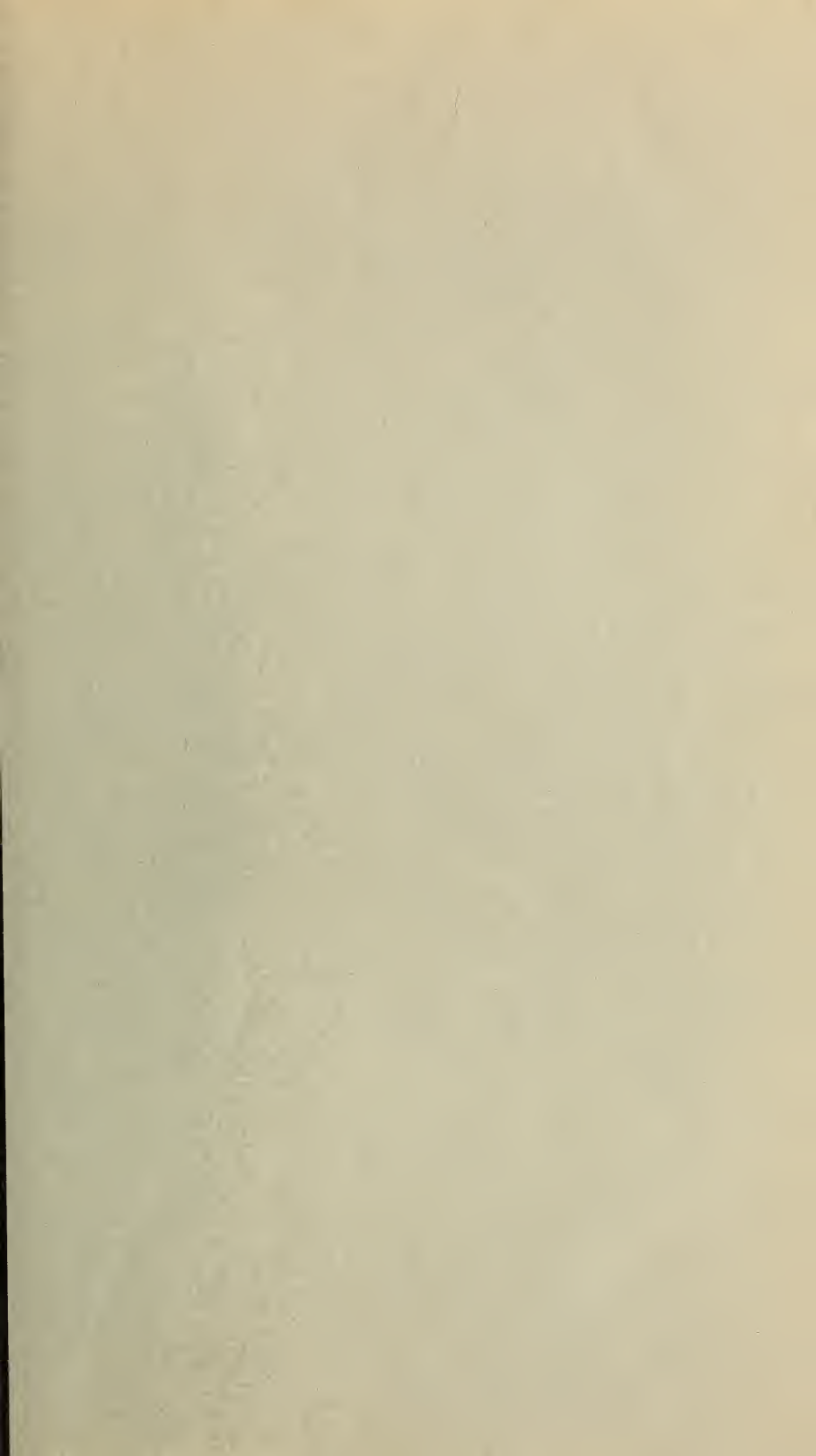
Item	Average annual consumption	Item	Average annual consumption
	<i>Kw.-hrs.</i>		<i>Kw.-hrs.</i>
Household appliances:		Dairy equipment:	
Refrigerator.....	360	Cream separator.....	35
Range.....	1,200	Milking machine—per cow.....	26.66
Water heater:		Water heater.....	1,500
Without bath.....	2,000	Ventilator fan.....	240
With bath.....	3,000	Churn.....	3
Freezer cabinet.....	900	Milk cooler—10 gallons per day.....	410
Washing machine.....	35		
Radio.....	100	Livestock equipment:	
Iron.....	60	Pig brooder—per spring litter.....	25
Clock.....	18	Tank heater.....	150
Toaster.....	35	Fence controller.....	50
Vacuum cleaner.....	20	Stock clipper.....	3
Household fan.....	15		
Food mixer.....	25	Poultry equipment:	
Heat pad.....	3	Brooder hover—per 100 chicks.....	72
Hot plate.....	70	Brooder—battery—per 100 chicks.....	100
Waffle iron.....	25	Water warmer.....	60
Space heater.....	70		
Sewing machine.....	10	Other farm equipment:	
Percolator.....	60	Grain elevator—per 100 bushels.....	333
Roaster.....	480	Corn sheller—per 100 bushels.....	5
Ironer.....	120	Seed cleaner.....	3
Coal stoker.....	240	Feed grinder.....	120
Oil furnace.....	300	Grain drier—per bushel.....	1.5
Hot-air fan.....	15	Hay hoist—per 100 tons.....	35
Hot-water pump.....	120		
Air-conditioning unit.....	2,000	Lighting buildings:	
Blanket.....	150	Dwelling.....	300
Broiler.....	50	General barn.....	24
Ventilating fan.....	25	Dairy barn.....	35-80
Ice-cream freezer.....	5	Beef barn.....	12
		Hog house.....	3
Water systems:		Poultry house.....	35
Pressure system:		Brooder house.....	5
Lift 22 feet or less.....	180	Milk house.....	35
Lift over 22 feet.....	240	Crib and granary.....	2
Gravity system.....	180	Garage.....	8
Pump jack.....	180	Shop.....	12
		Cave.....	5
Farm shop equipment:		Other buildings.....	12
Air compressor.....	35		
Drill press.....	12	Yard lighting.....	6
Tool grinder.....	25		
Power saw.....	12		
Welder.....	100		
Battery charger.....	12		
Lathe.....	12		
Forge.....	12		
Concrete mixer.....	5		
Soldering iron.....	15		

¹ U. S. Rural Electrification Administration and the Department of Agricultural Engineering, Iowa Agricultural Experiment Station.

TABLE 52.—*Factors for converting one head of different kinds of livestock into animal units of equal feed consumption*¹

Kind of livestock	Factor	Kind of livestock	Factor
Dairy cow.....	1	Spring pig.....	.19
Dairy heifer.....	.5	Fall pig.....	.19
Beef cow.....	.8	Feeder pig.....	.15
Feeder cattle.....	.8	Hens and pullets.....	.014
Other cattle.....	.4	Chicks.....	.004
Stock sheep.....	.15	Turkeys.....	.02
Feeder lamb.....	.07	Horses.....	.9

¹ One unit is equal to the total feed nutrients including hay and pasture consumed by one dairy cow in a year. Adapted from JENNINGS, R. D. ANIMAL UNITS OF LIVESTOCK FED ANNUALLY, 1919-20 to 1948-49. 35 pp., illus. Bur. Agr. Econ. 1949. [Processed.] Table 5.



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CHICAGO FIELD RECORD

1917 JUL 17